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# MOBILE LEARNING TECHNOLOGY: ASSESSMENT OF USERS' REQUIREMENTS, TECHNOLOGY OPTIONS, AND RECOMMENDATIONS

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# NAVAL POSTGRADUATE SCHOOL

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# THESIS

**MOBILE LEARNING TECHNOLOGY: ASSESSMENT OF USERS' REQUIREMENTS, TECHNOLOGY OPTIONS, AND RECOMMENDATIONS**

by

Shawntria M. Mosley and Russhell T. Evans

December 2021

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The Navy is in the process of implementing Ready Relevant Learning and looking at technology solutions to deliver modern training capabilities anytime and anywhere. Mobile learning is a practical option for Ready Relevant Learning. To support the Navy initiatives, we conducted a qualitative study to answer the following research questions: (1) Under what conditions will implementing mobile learning technologies provide the most value? (2) What are the requirements for delivering educational value to Navy users of mobile learning? (3) What are the pros and cons for Navy users of personal versus government-issued mobile learning devices? (4) How can Navy leaders select suitable options and deliver mobile learning?

We conducted 13 semi-structured interviews of Navy active duty, reserve, and civilian personnel across ranks and job communities to answer our research questions. We found that most participants were interested in mobile learning. Still, their acceptance of mobile learning technologies is dependent on their assessment of perceived ease of use of the technology and perceived usefulness to job performance. Additionally, we found that participants' device preferences were context-of-use dependent. Therefore, we recommend further evaluation of user requirements and to operationalize and test the usability factors identified to implement best practices for mobile learning.

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| BYOD | bring your own device |
| CAC | common access card |
| CNO | Chief of Naval Operations |
| CONUS | continental United States |
| COOL | credential opportunities online |
| DOD | Department of Defense |
| GMT | general military training |
| GSA | General Services Administration |
| IRB | Institutional Review Board |
| ML | machine learning |
| MLSE | mobile learning self-efficacy |
| MLT | mobile learning technology |
| MNL | MyNavy Learning |
| NETC | Navy Education and Training Command |
| NPS | Naval Postgraduate School |
| OCONUS | outside continental United States |
| PEOU | perceived ease of use |
| PII | personally identifiable information |
| PQS | personnel qualification standards |
| PU | perceived usefulness |
| RRL | Ready Relevant Learning |
| SDT | self-determination theory |
| SME | subject matter expert |
| TAM | Technology Acceptance Model |
| USMAP | United Services Military Apprenticeship Program |
| USNA | United States Naval Academy |
| VSH | virtual schoolhouse |

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—MAJ Shawntria M. Mosley, USA

I want to thank my family for their never-ending patience on so many days when I could not make it to family time. Justice and Jackson: you can have as many park days as you want now. Syama: I will watch the NJ Giants with you, but you know who the Superbowl champion will be. Shawntria, thank you for inviting me to work on this study with you. I could not have asked for a better partner to learn and grow together. I will miss our weekly talks to decompress before we start working on our thesis. I would also like to thank the NPS team, especially my professors and instructors. My time at NPS has been a one-of-a-kind experience, and you have been instrumental in expanding my world through knowledge. Last, to my cohort, I am so blessed to have met each of you. Thank you for always supporting, respecting, and laughing with each other as we take this journey together.

–LT Russhell T. Evans, USN

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# I. INTRODUCTION

The transformative Ready Relevant Learning (RRL) effort is transitioning the Navy to a modern, science-of-learning approach to training. This approach includes delivering novel training practices and content to the point of need, requiring a true "anytime, anywhere" capability (wireless access) for locations around the world and in continental United States (CONUS) learning centers and schoolhouses (Aten, 2020). To deliver modern training capability anytime and anywhere, the Navy must be able to support mobile and distributed training. Mobile learning requires that Sailors have access to both hardware and software that allow them to access training resources outside the classrooms, at the point of need, whenever they require it (Aten, 2020). Mobile learning is a practical option to realize the vision of the chief of naval operations (CNO). However, the Navy requires further understanding of factors likely to influence the adoption of the technology to guide implementation.

In addition to RRL, which is primarily focused on the training of enlisted Sailors, there is a broader initiative that supports mobile learning for everyone in the Navy. MyNavy Learning (MNL) is a proposed initiative that will synchronize the Navy's readiness objective with the agile learning methods that today's Sailors, uniformed and civilian, are accustomed to using (Naval Education and Training Command [NETC], 2021). This learning system solution for the future of Navy learning will "leverage a combination of technologies, science-based learning techniques, and artificial intelligence/machine learning (AI/ML) to achieve blended and adaptive training capabilities" (NETC, 2021, p. 5). Mobile delivery of training and support, resources at the point of need, personalized training capabilities, and performance assessment and feedback are among the five objectives NETC (2021) outlined in the MNL functional requirements document.

The MNL modernized approach to learning in the military environment offers service members the ability to engage in career-long learning and have point-of-need access to knowledge and information that can make a difference on the battlefield. Mobile learning is intended to support the point of need requirement of MNL for technical and professional development training of Sailors (NETC, 2021). The functional requirements document states that mobile technology in support of MNL should be able to deliver multiple training

modalities in various forms, including video, gaming, and virtual reality, and support collaborative approaches to learning (NETC, 2021). Although the military environment can be characterized as one where a consistent exchange of information and fast decision-making is critical, it is not clear how to best modernize the Navy's approach to mobile learning to meet this need.

There is limited research on mobile learning in military training. Previous studies have indicated that military members are somewhat interested in mobile learning and might use their mobile device or military-issued device to access learning content (Bayley & Bankus, 2017; Ruth et al., 2013; Schatz et al., 2019). An additional study found, consistent with the technology acceptance model (TAM; Davis, 1989), that the adoption of learning technologies in the Navy is dependent on how students and other users perceive the usefulness and ease of use of these technologies and that these perceptions drive assessments of the costs and benefits that ultimately lead to the intent to accept and use mobile technologies (Aten et al., 2018). Research provides considerable empirical support that TAM is an effective tool for predicting the acceptance and use of new technologies (Davis, 1989). A systematic review of TAM and adaptations of the theory found that it was the most widely used model for understanding the factors that influence and predict the adoption of technology, including mobile learning (Alsharida et al., 2021).

Our qualitative study investigates how the Navy can successfully implement mobile learning technologies under the RRL framework, drawing on the TAM. We interviewed Navy users (military and civilians) and analyzed the interviews to assess users' perceptions of the usefulness and ease of use of mobile learning technologies. We analyzed the data using qualitative data analysis techniques (Miles et al., 2014) by first focusing on identifying perceived usefulness. Davis (1989) defined *perceived usefulness* (PU) as "the degree to which a person believes that using a particular system would enhance his or her job performance" (p. 320). Next, we focused on identifying the role of perceived ease of use to define the costs associated with mobile learning technologies. *Perceived ease of use* (PEOU) is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). We interviewed Navy users to understand their perceptions of the benefits (usefulness) and costs (ease of use) of the various mobile device options (personal or

government-issued) in a mobile learning environment. Finally, we developed a framework that identifies and explains influencers of Navy users' decisions regarding the use of mobile technologies. The TAM provides the structure for assessing the value (cost/benefit) of mobile learning technologies. For Navy users, we equate intangible cost with ease of use and benefit to PU. This research identifies the conditions under which mobile learning technologies should be implemented to provide the most value. We identify and explain user requirements and provide a design roadmap to allow Sailors ready and usable access to mobile learning technologies that can deliver modern training content anytime and anywhere. In addition, we provide a model for assessing the best value solution for an effective technology ecosystem for hardware categories (laptop, tablet, mobile phone, etc.). The findings of our study support the organizational implementation and individual adoption of mobile learning in the Navy and across other military and DOD services.

## A. PROBLEM STATEMENT

The Navy requires ready, relevant learning and is unlikely to meet training and education needs without the use of mobile learning technology but lacks the understanding of what influences mobile technology adoption, which is needed for successful implementation. Researchers have investigated the evolution of mobile learning and its use in schools and commercial settings, but researchers have not investigated implementation in the Navy.

Navy education is centered on delivering everything a Sailor needs for their rating before they reach their first duty station. Thus, if the considerable knowledge and skills attained through training are not required at the first duty station and they need it at a later duty station, Sailors may have lost the skills and need a refresher. The CNO envisions an environment of "continuous learning to broaden and deepen warfighting knowledge, which will enable adaptation, improvement, and strengthen mission command to outthink and outfight any adversary" (Chief of Naval Operations [CNO], 2019, p. 5). The Navy must evolve and leverage mobile technologies for training to maintain a ready, relevant, and competitive force. To do this, we must better understand how to offer mobile learning environments that create value for the Navy and its students (CNO, 2019).

## B. PURPOSE STATEMENT

The purpose of this research is to create a value roadmap to help decision-makers build a suitable technology ecosystem for sustainable mobile learning in the Navy. To help the Navy better understand the context of use, we describe users' requirements in terms of usefulness and ease of use. PU and PEOU are very context dependent. The military is a unique environment, and research on how colleges and corporate institutions implement mobile learning may not be fully applicable to the military. We also describe desired Navy learning outcomes, goal-based use personas, general scenarios of use, high-level use cases, and PEOU. This framework serves as our core assessment structure. We compare technology options across this structure. Careful assessment of desired learning outcomes and a deeper understanding of the context of use of mobile devices ashore and afloat provides insight to guide mobile learning implementation in the Navy for the best value.

A 21st-century approach to learning through ready access to mobile learning technologies and the framework that supports this end state supports the ability to maintain a ready force and competitive advantage over the United States' adversaries. Thus, while the primary focus of this study is on naval personnel and scenarios of use in the Navy, the findings have implications for military organizations as well.

## C. RESEARCH QUESTIONS

This study answers the following research questions:

- Under what conditions will implementing mobile learning technologies provide the most value (learning/usefulness/ease of use)?
- What are the requirements for delivering educational value to Navy users of mobile learning?
- What are the pros and cons for Navy users of personal versus government-issued mobile learning devices?
- How can Navy leaders select suitable options and deliver mobile learning?

# II. LITERATURE REVIEW

Critical to the CNO's vision for RRL is the use of technology to instill continuous learning that will enable and improve the knowledge of Sailor warfighters to outthink and outfight any adversary (CNO, 2019). Research by Greg Gellman (2005) on computer-based blended learning noted that an increased operational tempo, such as occurs on helicopter amphibious assault ships, can affect overall mission readiness and capability when personnel are removed to attend training. His research emphasized the need to rethink traditional (schoolhouse) training approaches to realize travel, (learner/instructor) time savings, and increased flexibility.

The Navy wants to move away from what can be described as a timed-based linear system of learning at the beginning of a Sailor's career to a block learning structure under RRL (CNO, 2018). The key elements of RRL are "career-long learning continuum, modern delivery at point-of-need, and integrated content development" (U. S. Fleet Forces Command, 2017, p. 5). These lines of effort are geared towards leveraging learning technology to develop and deliver the right training anytime, anywhere; improve the retention of knowledge; and facilitate continuous improvement. The intent of mobility, accessibility, and flexibility through the RRL structure sets the stage for mobile learning as a modernized training delivery approach for the Navy.

In this chapter, we examine the concept of mobile learning, how it is distinguished from other learning paradigms, and its applicability to the military environment. Next, we present a broad description of the TAM, its fundamental elements, and its evolution, which incorporated additional variables. Finally, we review the concepts of PU and PEOU as foundational determinants of attitude towards technology use and behavioral intent.

## A. MOBILE LEARNING

Mobile learning is widely used in civilian schoolhouses and in the corporate environment. Researchers widely define mobile learning as the use of mobile technologies in learning and characterize mobile technologies based on portability (Chiang et al., 2016; El-Hussein & Cronje, 2010; Foti & Mendez, 2014; Jeng et al., 2010). Researchers generally

assume mobile technologies allow learners to move continually and often be wireless (Huang et al., 2010, p. 1). Chiang et al. (2016), accessed 130 mobile learning patents (patented between 1976 and 2013) and identified the recurring theme of easily retrievable, timely, and personalized learning content for seamless learning anywhere. Mobile learning varies from e-learning in several ways. Mobile learning is less formal than e-learning (Schatz et al., 2019), is shorter, has higher levels of usability, and offers increased personalization (Tucker, 2010). Alternatively, Jacob and Issac (2008) commented on the relationship between mobile learning and e-learning; "Mobile learning is defined as the intersection between mobile computing (the application of small, portable and wireless computing and communication devices) and e-learning (learning facilitated and supported through the use of information and communications technology)" (p. 1). Mobile learning can also refer to the mobility of the terminal equipment being used in the learning process (Ma, 2017) and how it aligns with the mobility patterns of modern students (El-Hussein & Cronje, 2010, p. 14).

The many definitions of mobile learning bring to focus the emerging nature of this concept. Hockly (2013) acknowledged a debate among some researchers on whether mobile learning focuses on the learner's mobility or the portability of mobile learning devices. Hockly (2013) offered that both aspects of mobile learning are important, but the key is to assess how learners' interaction with mobile devices in any context leads to actual learning. The impact of mobile devices on learning is evident in yet another definition of mobile learning: "Mobile learning is the acquisition of knowledge and skills using mobile technologies and devices at any place and time, and this corrects the behavior and the mentality of students" (Kumina & Sheleva, 2013, as cited in Sattarov & Khaitova 2019, p. 1170). In their research, Kumina and Sheleva (2013, as cited in Sattarov & Khaitova 2019), acknowledged that mobile learning modifies the learning process in that learning materials are presented and accessed in new ways, creating new forms of knowledge transfer and modifying learners' level of participation in the learning process. Ng et al. (2013, as cited in Alghazi et al., 2021) also acknowledged this change in the balance between the learning process and the learner in mobile learning. Their research concluded that the ability of a

student to learn independently increases their interactions with other learners and their interaction with the information provided.

Mobile learning technologies often described include mobile devices such as smartphones, tablets, or e-readers (Aten et al., 2018; Mercado & Spain, 2014), as well as laptops, personal digital assistants, and iPods (Jacob & Issac, 2008). Other researchers offered that mobile learning technologies can also include network and multimedia technology (Berge et al., 2013; Chiang et al., 2016). These characteristics of mobile learning technologies imply that learning can occur anywhere and anytime, an important concept to the Navy's vision for learning. For this research, we defined mobile devices strictly by portability or mobility as characterized by the freedom of movement and handling while standing, sitting, or in transit. Specifically, mobile devices for this research are laptops, smartphones, and tablets (e.g., iPads and small notebooks). The size and portability of these handheld devices make them a popular daily companion to most adults, easily accomplishing daily communication tasks, socializing, gaming, directions, research, training, and more.

Aten et al. (2018) proposed that the portability and mobility of mobile devices facilitated positive technological attributes for learning such as individuality and interactivities. In their study, participants indicated that individualizing the training delivery method contributed to training effectiveness. Additionally, an interactive learning environment that allowed content modification was desirable and a key usability needed for learning technology adoption. Looking at telepresence and interactivity in mobile learning, Wei and Li (2021) also found that users' interaction and communication in a learning system can increase learning effectiveness. The insights on these technological attributes for learning are vital as successful learning in a virtual environment requires students to engage in self-regulated learning, being able to customize their learning environment (Aten & DiRenzo, 2014). Aten et al., in their 2018 work, further supported this point in their findings that mobile devices and technology owned or familiar to the students increased students' motivation to engage in the learning process. This might indicate that the level of control and individualization a user experiences using their personal mobile device has a positive impact on the learning process.

Trentin and Repetto (2013) also found that mobile devices increased intrinsic motivation. They cited the self-determination theory (SDT) and learners' need for autonomy, competence, and relatedness. These three SDT needs can be attained using mobile devices because of the devices' portability and other distinguishing features that make their use enjoyable and encourage prolonged positive engagements in learning activities (Trentin & Repetto, 2013). Both these studies are consistent with Huang et al. (2007), who found that mobility was the most valued feature of mobile learning, which was an essential finding towards user acceptance of mobile learning. Participants in their study also perceived mobile learning as enjoyable.

There are several ways to utilize mobile devices in a mobile learning environment. Sattarov and Khaitova (2019) offered that mobile devices can be used to access a network that hosts the training material, as a training platform with learning content embedded in the device memory, for creating training programs through a mobile game shell, and to facilitate communication between the teacher and other learners to freely pass learning information (email, text, messaging, etc.). There are disadvantages noted in the use of mobile devices in learning, however. Some disadvantages are characteristic of the mobile devices used. Sattarov and Khaitova (2019) noted a few of these disadvantages, including limitations to the amount and type of information displayed, storage limitations, loss of data accompanying loss of battery power, and the speed at which mobile technology becomes outdated. Alghazi et al. (2021) included that some training materials developed for desktop computers might be incompatible with mobile devices unless modified. Disadvantages to mobile learning indirectly associated with the mobile devices include low bandwidth and issues accessing a wireless network (Sattarov & Khaitova, 2019).

However, despite the disadvantages, mobile learning technology allows for personalized learning and can be a valuable tool for lifelong learning, an important concept to the Navy. In his work on designing personal mobile technologies for lifelong learning, Sharples (2000) noted that new technologies allow learners to manage lifelong learning and facilitate collaboration and access to information at the point of need. Sharples presented the preconditions for a mobile learning environment to facilitate lifelong learning (see Table 1). Table 1 was also used in *The SAGE Handbook for E-learning Research*,

where Sharples et al. (2016) discussed the theory of learning for the mobile age. Sharples et al. acknowledged the increasing functionality of mobile technologies as wireless computers, and their role in the evolution of learning. These researchers recognized that "another equally important convergence is occurring between the new personal and mobile technologies and the new conceptions of learning as a personally-managed lifelong activity" (p. 68).

Table 1. The Match of New Communications and Information Technology to Lifelong Learning. Adapted from Sharples (2000).

| **Lifelong Learning** | **New Technology** |
|---|---|
| Individualized | Personal |
| Learner centered | User centered |
| Situated | Mobile |
| Collaborative | Networked |
| Ubiquitous | Ubiquitous |
| Lifelong | Durable |

Leveraging the best features of mobile devices can have tremendous benefits in the mobile learning environment. However, learners must also accept mobile learning as a learning option (Alghazi et al., 2021). The individual contexts for mobile learning may provide insights into the factors that can lead some learners to accept mobile learning technologies. "Context-awareness tends to involve adapting systems to the users or their environment by capturing and understanding contexts" (Vallejo-Correra et al., 2021, p. 2). Contexts incorporate how learners prefer to learn the educational content, the information presented, and the users' connection to the available services and interface (Vallejo-Correa et al., 2021). Similar to the concept of context-awareness, Parsons et al. (2006) identified the importance of understanding user profile and user roles. Each user's interaction with their mobile device is different. This difference is critical to how they may apply the use of their mobile devices in learning.

## B. MOBILE LEARNING IN THE MILITARY

The use and benefits of mobile learning are well documented in the civilian industry, but literature on this modernized approach to learning in the military is rare. Researchers have noted that the education of the military, an essential service to the state, should be of the highest priority (Berge et al., 2013). Military members serve in an environment where information needs are constant and knowledge management is essential (Berge et al., 2013). Military members, however, have not been a popular target for mobile learning studies. Berge et al. (2013) proposed that mobile learning, specifically mobile knowledge management in the military, can facilitate "fast updating of learning objects according to military requirements and realities" (p. 1168). These are similar sentiments to what the Navy wants to achieve with RRL: provide Sailors with the initial training, then the fleet commanders will determine what other training is needed for their specific job or environment.

We began the literature review with a broad search for literature on mobile learning in the military. There are a handful of scholarly articles or research on the exact applications of mobile learning in the U.S. military, but the reviewed publications all agree that mobile learning is an option for modernizing learning in the military (Ma, 2017; Ruth et al., 2013; Schatz et al., 2017, 2019; Tucker, 2010). Tucker (2010), in his research note on *Mobile Learning Approaches for U.S. Army Training*, highlighted the potential of mobile learning as an effective tool that can facilitate lifelong learning in the military if developed with appropriate pedagogical practices. In their article, "The Changing Face of Military Learning," Schatz et al. (2017) proposed five "enabling conditions" for the future of military learning. Condition one is "cultivating ubiquitous learner-centric, technology-enabled instruction" (p. 82). The authors described this as an investment in fully blended learning that is ubiquitous, characterized by the seamless assimilation of formal and informal learning throughout training and operational duties. Under this condition, systems used in the military are integrated into the learning and assessment process where performance can be assessed for lessons learned and further training assigned accordingly (Schatz et al., 2017). Bayley and Bankus (2017) reviewed course designs for Army e-Learning; however, the use of mobile learning was a point towards designing future courses

with mobile learning principles in mind because moving learning material into the cloud increases opportunities for Army personnel to access content via their mobile devices.

Ruth et al. (2013), Schatz et al. (2019), and Migdalski (2019) used surveys in their studies to assess different aspects of mobile learning in the military. Ruth et al. (2013) conducted a survey of Naval Postgraduate School (NPS) distance-learning graduate students and U.S. Naval Academy (USNA) undergraduate students on behalf of the NPS Center for Education Design, Development, and Distribution. They found that it has become the norm for students to use smartphones in the classroom to access learning material, and a majority of the students sampled "would use mobile learning if it were available" (p. 25). Similarly, Schatz et al. (2019), in assessing the future of learning in defense, surveyed military personnel responses to the top 25 modernized learning trends in the civilian industry. The authors found that mobile learning (as a trend in learning delivery) and point-of-need learning (as a trend in learning design) had the most interest from participants to modernize the learning system of their respective military service. The participants were military personnel from five different countries, including the United States, who worked in a military training capacity (Schatz et al., 2019). These results are not surprising considering the consistent increase of mobile devices on the market. The International Telecommunication Union reported over 7 billion worldwide mobile phone subscriptions, a 10-fold increase since 2000 (International Telecommunication Union, 2015, as cited in Haenssgen, 2019). With the expansion of technology, widespread reliance on touch-screen devices such as smartphones and tablets is becoming unavoidable (Claypoole et al., 2016; Haenssgen, 2019). Real-world military relevance is overwhelming, with the power and extensibility of small wireless devices—available worldwide—that allow real-time interactives for task and mission completion as well as data gathering and reporting of actual events (Roth, 2002). To this point, Roth offered that mobile devices can be used in a myriad of ways for military purposes, including improvements in teaching and communication on ships.

Personal versus government-issued mobile devices will need to be addressed in the context of mobile learning in the military. Two studies provided preliminary insights on how mobile devices are used in the military environment. Mercado and Spain (2014)

surveyed Army Soldiers on their ownership and use of mobile devices and found that "if issued an Army smartphone, most Soldiers would be comfortable incorporating it into their work environments" (p. 26). Additionally, 67% of their participants said they used an Army-issued smartphone to access technical field manuals and online training. More relevant mobile learning activity—military instructors' experiences—were assessed in relation to students' use of bring-your-own devices (BYOD) in the classroom, and the results were mixed (Migdalski, 2019). Twelve instructors who provided cyber communications to enlisted students at a cyber communications training campus were interviewed to capture their teaching experiences, quality of instructor-to-student collaboration, and quality of discourse when BYOD was used in learning activities (Migdalski, 2019). Migdalski found that students conducted more self-directed and peer-to-peer learning, and initial instructor experiences were different depending on whether they adopted BYOD in the classroom early in the implementation or after full implementation, but "over time the participants evolved to view the transition as positive in the teaching and learning environments" (p. 155). While preliminary and limited, these two studies showed that some Army Soldiers would use government-issued devices in the process of learning, and another subset of military students effectively incorporated personal devices in their military learning experience.

The military studies cited above in this section looked at the potential for mobile learning in the military environment; however, none provided an implementation plan nor recommendations for devices or systems that would provide the best value in the military environment. Participants in the study by Schatz et al. (2019) indicated that while they perceive value in mobile learning, there are barriers to implementation; for example, there are no policies in place to provide a roadmap, but they believe their respective organizations are "near" (referencing close to adoption). Similarly, Ruth et al. (2013) concluded that "the big question is not whether to transition to a mobile technology, but how" (p. 28).

## C. IMPLEMENTING MOBILE LEARNING

Sharples et al. (2016) believed that to put forth a theory of mobile learning, best practices in the theory of learning is essential. In their assessment of successful learning, Sharples et al. cited a 1999 National Research Council report that proposed four measures of effective learning: learner centered, knowledge centered, assessment centered, and community centered. Similarly, Park's (2011) research suggested that implementing mobile learning requires a theoretical framework that allows for pedological considerations. Park argued that "the most serious issue faced by mobile learning is the lack of a solid theoretical framework which can guide effective instructional design and evaluate the quality of programs that rely significantly on mobile technologies" (p. 83).

In defining mobile learning, we identified literature that proposed that mobile learning is different from e-learning. This point was made since the military has been using e-learning for several years. Applications such as Navy e-Learning and Army Knowledge Online are mandatory online destinations for command-directed training and self-guided training for Sailors and Soldiers. A Parsons et al. (2006) study on the design requirements for mobile learning, however, stressed the importance of recognizing that an e-learning design cannot be used in mobile learning because the limitations and benefits of mobile devices make the delivery of learning content unique. The unique design requirements of mobile learning, as proposed by Parsons et al. (2006), include "generic mobile environment issues, learning contexts, learning experiences, and learning objectives" (p. 1). Mobile environment design requirements include the ability to always communicate, despite the environment. This requirement encompasses the mobility of the device, user, and services, and understanding users' interface constraints. Learning contexts' design requirements relate to the situational context (e.g., learner and activity) and environment (e.g., facility). Learning experiences design requirements bring to focus user experience goals that will lead to satisfaction. The final design requirement, learning objectives, maps the skills developed by a learner from the learning experience. Figure 1 is the framework used by Parsons et al. (2006) to demonstrate the interaction between the four design requirements outlined in their study.

In a similar study, Nordin et al. (2010) investigated mobile learning supporting lifelong learning. The researchers proposed a mobile learning design framework for lifelong learning that incorporated many generic elements of the Parsons et al. (2006) framework, adding "theories of learning" as an additional element. Nordin et al. (2010) believed that learning theories are essential to the design of the learning materials, and those learning materials will influence the approach to learning. The significance of these research studies is the idea that the operational success of mobile learning requires the acknowledgment of the differences of mobile learning compared to other learning approaches and incorporating this uniqueness into the design of the mobile learning system. This idea is important for any organization that seeks learners' acceptance of mobile learning compared to traditional learning methods.

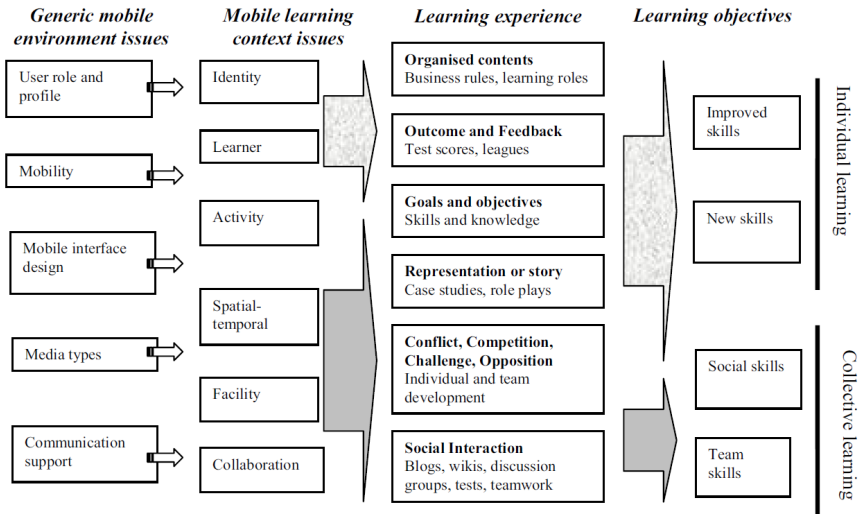


Figure 1. A Framework for Mobile Learning Design Requirements. Source: Parsons et al. (2006).

## D. TECHNOLOGY ACCEPTANCE MODEL

Fred Davis proposed the TAM in 1985 to explain system acceptance in a period when organizations were experiencing system adoption failures (Chuttur, 2009). In the original model (see Figure 2), Davis proposed that "the attitude of a user toward a system was a major determinate of whether the user will actually use or reject" (Chuttur, 2009, p.

2). This original model presented PU and PEOU (influenced by external variables) as the determinants of "attitude toward use." The model was revised in 1989 by Davis et al. to include a new variable, "behavioral intention to use" (see Figure 3). This revised model identified behavioral intention as the only direct indicator of actual use with all other factors influencing attitude and/or behavioral intent.

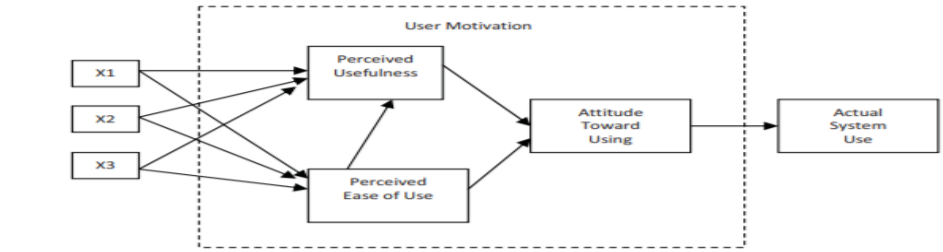


Figure 2. Original TAM Proposed by Fred Davis.
Source: Davis (1986, as cited in Chuttur, 2009).

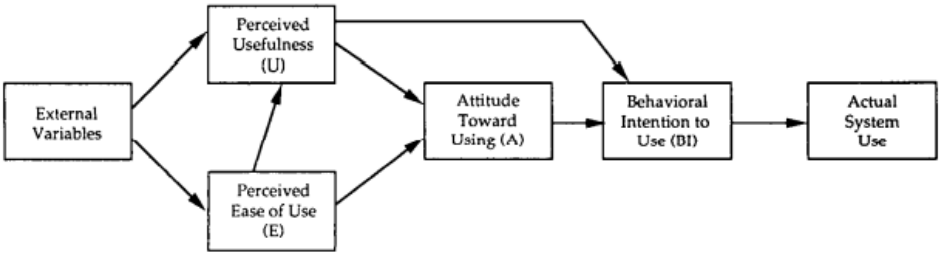


Figure 3. Technology Acceptance Model. Source: Davis et al. (1989)

Despite criticism regarding its simplicity and lack of consideration for the influence of subjective norms on behavioral intention, the TAM has been justified with over 2 decades of research in its use for new technology adoption (Buabeng-Andoh, 2018). Both Buabeng-Andoh (2018) and Huang et al. (2007) agreed that the TAM is a suitable model for exploring user acceptance of mobile learning, and we will structure our assessment of the value (cost/benefit) of mobile learning technologies based on the TAM.

"The major goal of TAM is to forecast the adoption of new technology among users and to highlight the design problems of the information system before its usage becomes

prevalent among people" (Mun et al., 2006, as cited in Kamal et al., 2020, p. 2). Central to the TAM are the key attributes of PU and PEOU as predictors for people's attitude towards use, which then influences the behavioral intention (willingness to continue to use), leading to the endpoint of actual use (Alsharida et al., 2021; Buabeng-Andoh, 2018; Kamal et al., 2020). Specific to mobile learning, Huang et al. (2007) applied Davis's early version of the TAM and found that "perceived usefulness (PU) and perceived ease of use (PEOU) are key determinants of user perception of M-learning [mobile learning]" (p. 594). For a more robust TAM, external factors that improve the model's predictive capability have been explored over the years. For example, an extended TAM might include cognitive absorption, technical support, and compatibility of the technology (Levy & Green, 2009).

Levy and Green (2009) used an extended TAM in their study of information systems adoption in the U.S. Navy, adding computer self-efficacy, and found that computer self-efficacy had a notable impact on usefulness and ease of use. However, usefulness had the most impact on intention to use (though influenced by both self-efficacy and ease of use). Essentially, how users perceive their ability to use a computer and the perceived difficulty of using the information system influenced PU. Aten et al. (2018) also used an extended TAM in their study (see Figure 4), using precursors of "Experience and Belief" to the perception of usefulness and ease of use. Notably, they found that "individuals' experience with mobile technologies and their beliefs about organizational support influence their perceptions of the usefulness of MLT [mobile learning technologies] and ease of use" (Aten et al., 2018, p. 15). While their study did not highlight PEOU as an influence on PU, they were consistent with Levy and Green and the TAM in general, in that PEOU and PU are critical predictors for acceptance. It must also be noted that Aten et al. (2018) used "Assessment" as a factor that influences behavior intentions. In this assessment, individuals assessed the value of mobile learning technologies through benefits and costs as a result of the PU and PEOU. Where there were higher perceived benefits, acceptance of mobile learning technologies was predicted (Aten et al., 2018).

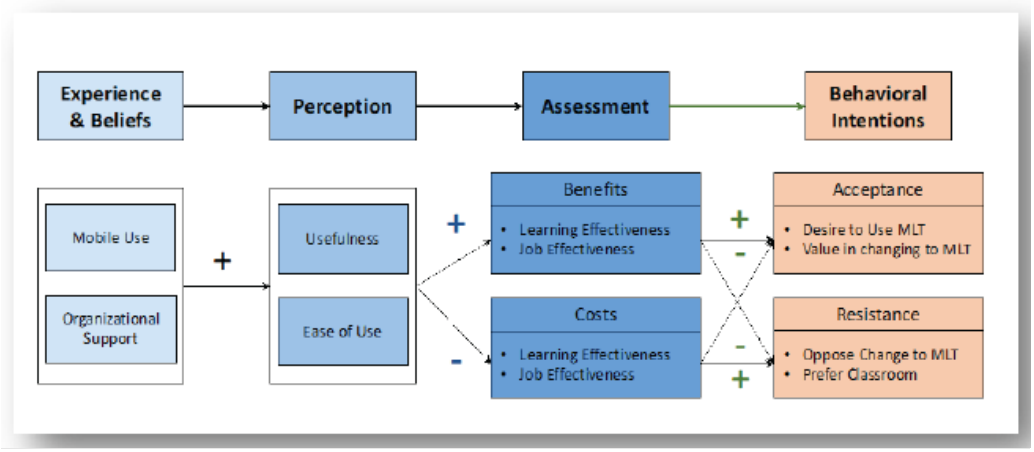


Figure 4. A Model of Mobile Learning Technology Acceptance.
Source: Aten et al. (2018).

It should also be noted that a more definitive application of self-efficacy has emerged in mobile learning studies. "Mobile learning self-efficacy is defined as perceived behavioral control that depicts students' personal beliefs in their competence in performing a learning activity using their mobile devices" (Cheon et al., 2012, as cited in Kumar et al., 2020, pp. 208061–208062). Kumar et al. (2020) used a hybrid TAM in their study. They were able to develop parameter estimates for a structural model that outlined the significant and nonsignificant factors of behavioral intention (toward the use of mobile learning by engineering students). Mobile self-efficacy had both significant and nonsignificant impacts on most other model factors, including behavioral intent. Figure 5 is a model of their results.

A Kumar et al. (2020) study on behavioral intention to use mobile learning found that a solid framework for the implementation of mobile learning must include an assessment of the attributes that influence users' willingness to use mobile learning technologies. The literature in this section suggests that this assessment must include, in large part, the concepts of PU and PEOU.

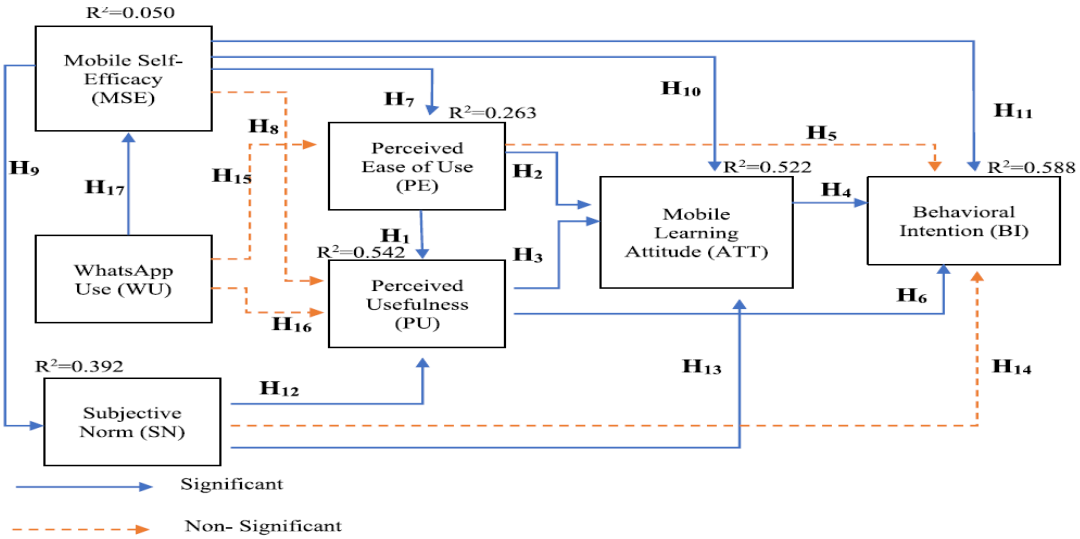


Figure 5. Parameter Estimates for the Structural Model.
Source: Kumar et al. (2020).

## E. PERCEIVED USEFULNESS

In his 1989 work, Davis defined PU as "the degree to which a person believes that using a particular system would enhance his or her job performance" (p. 320). Davis asserted that enhancing job performance is essential to users in an organization where good performance is rewarded. Thus, a positive use-performance relationship, from the user's perspective, is expected to result in an intention to use the new technology. Davis conducted two studies to test PU and PEOU for reliability and content validity. He found that usefulness was a more significant indicator of system use than ease of use because of its relationship to behavioral intent. Davis et al. (1989) presented a TAM where behavioral intention to use was determined by attitude toward using and PU (see Figure 3). This relationship was attributed to the idea that "within organizational settings, people form intentions toward behaviors they believe will increase their job performance, over and above whatever positive or negative feelings may be evoked toward the behavior per se" (p. 986). This conclusion can be attributed to the earlier point that the expectation of rewards for good performance influences intention to use.

Similarly, a Kumar et al. (2020) study on behavioral intent in mobile learning also found a strong relationship between attitude, PU, and behavioral intent (see Figure 5).

Likewise, Scherer et al. (2019), in their meta-analysis of TAM studies involving teachers' acceptance of technology in their teaching practice, found that usefulness, predicted by subjective norms and computer efficacy, had a more significant impact on intent to use. On the other hand, Buabeng-Andoh (2018), in his study predicting university students' intent to use mobile learning, found that PU had an indirect impact on intent. The difference between Scherer et al. and Buabeng-Andoh's research population might explain the polar effect of the results. The university students placed greater value on the effort it takes to use the technology and engage in mobile learning (Scherer et al., 2019), while teachers (Buabeng-Andoh, 2018), office workers, and MBA students with work experience (Davis, 1989) found greater value in technology that can improve their job performance.

The evolution of the TAM reflects researchers' initiatives to demonstrate additional factors that can affect PU, PEOU, and/or intent to use new technology. Many factors have been assessed to directly influence PU. For example, in his early research on the TAM, Davis (1989) refined his PU scale based on the results and validation of two studies on technology acceptance. This scale refinement led to six factors that were influential to the PU of new technology by study users. System users in their study expected and rated PU of the system using the following factors:

1. Work More Quickly
2. Job Performance
3. Increase Productivity
4. Effectiveness
5. Makes Job Easier
6. Useful (Davis, 1989, p. 331)

In their study, Holden and Rada (2011) used identical measures of PU (assessed using a 7-point Likert scale). In addition, Holden and Rada used an extended TAM to evaluate teachers' technology acceptance by incorporating usability and ease of use factors. Their study found that the combination of perceived ease of use and usability (PEUU) factors strongly influenced PU. They offered that this finding is both significant to the design and development of educational software to meet individual needs and is generalizable to other populations.

In a more recent study, Saroia and Gao (2019) investigated university students' intent to use a mobile learning management system using three moderators to Davis's TAM. These new factors were perceived mobility value, academic relevance, and management support—all influencing PU. In this study, perceived mobility value was descriptive of users' perceived advantage of using a mobile device anytime anywhere for learning. Academic relevance to the students was likened to job relevance, in the belief that the system was applicable to job functions (in this case, academic tasks). Finally, management support is students' assessment of the university's commitment to ensuring user satisfaction. Study results indicated a significant impact of PU on attitude towards use and behavioral intent. Additionally, Saroia and Gao found that mobility and relevance positively impacted PU (expectation of increased performance) but were surprised that management support did not significantly influence PU. This finding on management support was inconsistent with their literature review.

Another notable external influence on PU is compatibility. Chang and Tung (2008) defined compatibility as "the degree to which the innovation is perceived to be consistent with the potential users' existing values, previous experiences and needs" (p. 75). In their study of students' behavioral intentions to use online learning course websites, Chang and Tung extended the TAM to include compatibility. They found that compatibility had a direct and significant effect on both PU and behavioral intent. It should be noted that this study also found that computer self-efficacy was the most critical factor towards behavioral intent. The impact of computer self-efficacy is unsurprising. The study looked at the acceptance of online learning courses; users' positive belief in their ability to use a computer could be reasonably expected to encourage behavioral intent.

This review on PU supports identifying factors important to the successful adoption of mobile learning technologies by Navy users. PU and its demonstrated effect on attitude and, most impactful, behavioral intent is critical to designing and implementing a mobile learning environment where users can find value in mobile learning technologies.

## F. PERCEIVED EASE OF USE

One important aspect in product design and implementation in organizations is the consideration of the user. However, our literature review unveiled that some challenges exist. Kujala et al. (2001) highlighted the challenge in making "a usable product created by a technical designer" and argued that "designers should incorporate user needs and requirements into the user's interface to increase usability" (p. 1). Research of Navy personnel by Hall and O'Connor (2018) highlighted that a communication gap in incorporating new technologies has often excluded servicemembers at the lowest levels. Kujala et al. (2001) explained a critical step in closing knowledge gaps between users and designers is to collect user needs directly from users. Hall and O'Connor (2018) further emphasized that the absence of "perspectives, feedback, and experiences" (p. 78) from across all levels and ranks created a lack of understanding of user needs and decreased usability.

Tahir and Arif, (2014) identified "effectiveness, efficiency, learnability, understandability, operability, attractiveness and satisfaction" (p. 158) as usability characteristics. Bevan et al. (2016) defined usability as "the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (p. 269). In 2016, Bevan et al. detailed the importance of appropriate user feedback to confirm actual versus perceived outcomes to improve user effectiveness. Effectiveness has been defined as "accuracy, completeness and the lack of negative consequences with which users achieved specified goals" (Bevan et al., 2016, p. 269). Views from Hall and O'Connor (2018) were further supported in literature by the Bevan et al. (2016) study, which stated that aspects that satisfy the user have been identified as "positive attitudes, emotions and/or comfort resulting from use of a system, product or service" (p. 270). Tahir and Arif (2014) also emphasized the critical aspect of including "usability and user experience in creating successful applications" (p. 156) to improve usefulness, minimize common problems, and enhance mobile learning technologies.

Some examples provided by Bevan et al. (2016) illustrate what organizations should focus on to mitigate usability challenges with perceived user success (e.g., failure

to submit a vote when a voting machine did not generate feedback for a successful submission) and perceived user failure (e.g., rebooking a flight if a booking confirmation is not generated). Recommended areas of focus include usability, accessibility, user experience, and mitigation of risks (Bevan et al., 2016). Additionally, Bevan et al. (2016) identified four areas of usability important to users' view of effectiveness, efficiency, and satisfaction: learnability (learning to use a new system), regular use, accessibility (broad scope of capabilities), and maintainability (maintenance tasks).

According to Mayhew (2013, as cited in Galletta & Dunn, 2014), "Ease of learning measures how intuitive an interface is for new users, while ease of use indicates how quickly memorized operations can be executed in accomplishing a task" (p. 77). Galletta and Dunn (2014) argued that when choosing a mobile learning technology, decision-makers should consider the necessary adoption factors users require to make the technology both easy to use and easy to learn. Additionally, organization-specific tasks should be developed to determine ease of use when a mobile learning technology adoption decision is made (Galletta & Dunn, 2014). Galletta and Dunn further provided that when decision-makers assess ease of learning, users should be unfamiliar with the mobile learning technology to more accurately measure how easy the technology is to learn. Learnability was determined by evaluating non–smartphone users' performance on unfamiliar platforms that identified miscellaneous clicks and decreased speed during performance attempts as triggers for frustration (Galletta & Dunn, 2014). In assessing ease of use for experienced and new smartphone users across four platforms (Blackberry, iPhone, Windows, and Android), Galletta and Dunn found that the Blackberry was the fastest platform among the former group, whereas the iPhone took the longest but was the fastest for new users, followed by the Windows platform. The Android platform ranked third for both groups.

In addition to evaluating learner/user requirements for different mobile device options, understanding the larger context of technology adoption at the organizational level is important to our study. The key to mobile learning sustainability, as presented by Cochrane (2010), is an institutional cultural and strategy shift to self-directed learning both from the lecturer and student perspectives. Similarly, Aten et al. (2018), in conducting

stakeholder interviews, found that "organizational-level activities influenced the implementation of learning technologies included in the organizations' strategic direction and technology implementation initiatives" (p. 4). Schatz et al. (2019) also found that the military training representatives interviewed for their study perceived "lack of policy guidance, cybersecurity concerns, coordination issues with developing and disseminating m-learning content, and network infrastructure limitations" (p. 9).

## G. SUMMARY

Understandably, an issue of concern in the military is security in the use of mobile devices in the work environment and the control of access to information. Roth (2002) argued that as military information technology specialists, it is imperative that emerging technologies are implemented in Department of Defense (DOD) learning and training strategies, although some inherent risks to security may be assumed. Additionally, he suggested that future studies should address "appropriate security evaluation, training and implementation techniques in regards to emerging wireless technologies" (Roth, 2002, p. 110). Future studies should also "catalog a knowledge base of specific applications/tools, wireless technology use, and security/supportability concerns across DOD" (Roth, 2002, p. 110).

As the use of mobile technology increases, more research emerges on its applicability to the learning environment. Effective and sustained learning and development—using mobile learning technology that empowers Sailors to self-direct their learning—offers more flexibility for when and where learning occurs and will make the difference between which force is better prepared on the battlefield. Owing to the extensive applicability of the TAM in technology adoption research, our study uses PU and PEOU as the primary factors affecting attitude and behavioral intention to use mobile learning technologies in the Navy. To get to a point of fully utilizing the advantages of mobile learning, we must investigate the conditions that need to exist to implement mobile learning in the Navy at the best value for the users and the organization.

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# III. METHODS

This chapter describes the research design and methods. This qualitative analysis relied on grounded theory analysis techniques to analyze interview data. The analysis resulted in a description of Navy learners' views and experiences and a model that explains the adoption and implementation of mobile learning in the Navy. In this chapter, first, we discuss our research approach. Then we outline our data collection procedures. Last, we describe the data analysis process used to arrive at the study results.

## A. RESEARCH QUESTIONS

This qualitative study answered the following research questions:

- Under what conditions will implementing mobile learning technologies provide the most value (learning/usefulness/ease of use)?
- What are the requirements for delivering educational value to Navy users of mobile learning?
- What are the pros and cons for Navy users of personal versus government-issued mobile learning devices?
- How can Navy leaders select suitable options and deliver mobile learning?

## B. QUALITATIVE RESEARCH APPROACH

We applied a qualitative research approach with a constructivist worldview to this study. According to Creswell and Creswell (2018), a qualitative research approach allows researchers to inductively build themes and a theory from data collected from individuals as the individuals apply meaning to social or human problems. Furthermore, Creswell and Creswell offered that the basic set of beliefs individual researchers hold (i.e., worldview) will shape the research approach employed in the study. A constructivist worldview allows for assessing multiple participants' views and theory generation and is most associated with qualitative research. For this study, we needed to rely heavily on the participants' perspectives, noting meaningful contexts that might influence their views on learning and

mobile learning technologies in the Navy. As a result, a qualitative study and a constructivist approach were appropriate for this study.

For this qualitative study, we drew on analysis techniques developed for grounded theory. These techniques prescribe that researchers collect data in multiple stages (Creswell & Creswell, 2018) and iteratively collect data and analyze the data simultaneously, allowing each process to influence the other (Thornberg & Charmaz, 2014). "A grounded theory is derived from participant data that is fractured, compared, and raised from the level of raw data to that of more abstract concepts" (Nathaniel, 2021, p. 2). Furthermore, it is emergent, conceptual, and perspective-oriented. As data are collected, the data are inductively analyzed and compared for patterns that form the building block for concepts and a theory, all from the participants' perspectives (Nathaniel, 2021). We applied an iterative data analysis process to this study, which aligned with the grounded theory. Participants' interview data were systematically collected, analyzed, and compared for themes to build theory and to influence further interviews and literature review. Consequently, there was not a set sample of participants at the beginning of the study. While the structured interview questions were the same, we sought new participants whose perspectives might confirm or refute concepts, themes, or theories developed from previous data collected.

## C. DATA COLLECTION

We collected data through open-ended, semi-structured interviews. The NPS Institutional Review Board (IRB) reviewed and approved the study and interview protocol. Semi-structured interviews allow participants to freely share their views, allowing researchers to interpret, organize, code, and formulate themes to understand the data better (Creswell & Creswell, 2018). Additionally, Creswell and Creswell stated that interviews are advantageous in qualitative studies as participants can provide historical information on the area of interest. Semi-structured interviews also give researchers control over the line of questioning and flow of the data collection process. Furthermore, Thornberg and Charmaz (2014) emphasized that using grounded theory analysis techniques does not require a specific data collection method—instead, whichever method or methods "best fit

the actual research problem and the ongoing analysis of the data" (p. 155). Semi-structured interviews allowed us to ask probes with additional questions and focus on emerging areas of interest, illuminating concepts and their possible implications. The data collection methodology used in our thesis was adopted from Hall and O'Connor's 2018 thesis entitled *Learning Technology Adoption: Navy Barriers and Resistance*. Like Hall and O'Connor's (2018) study, our analysis includes a thorough literature review; however, due to COVID-19 pandemic safety measures, we conducted virtual interviews with our participants. Our literature review focused on mobile learning technologies to identify users' themes that influence adoption requirements and preferences. Our interviews provided a means to collect and analyze perspectives of naval personnel—active duty and reserve military (officers and enlisted) and civilian personnel—on the adoption of mobile learning technologies based on context of use. Thus, our data applied a thematized analysis to examine a diverse group of naval users' feedback and experiences with mobile learning technology adoption with the themes we identified.

### 1. Purpose

We strived to understand the perspectives of personnel in different command settings: on ships, outside continental United States (OCONUS), deployed, and in the various CONUS commands. In addition to including an extensive review of existing literature, our quantitative data analysis was based on a Miles et al. (2014) study and aimed to include 10 to 25 Navy personnel to participate in virtual interviews. The ability to conduct virtual interviews broadened the range of participants to geographical areas outside of the local NPS population and allowed for increased diversity. As with Hall and O'Connor (2018), both the existing literature and the interviews conducted were examined and categorized using themes identified in the literature or collected from participants' experiences with Navy learning. The purpose of reviewing the literature was to explore existing trends and fill gaps to assist the Navy in user adoption preferences prior to implementation of new mobile learning technologies. The purpose of conducting interviews was to identify and provide an analysis of the users' requirements for the adoption of mobile learning technologies based on a diverse population of Navy personnel.

## 2. Setting

We emailed potential participants (see Appendix A) to solicit volunteers for our research. As participants volunteered to participate in our study via email, we scheduled and conducted the interviews virtually. We allowed participants the flexibility to choose the most convenient time and preferred virtual interview method that would offer the most comfort and privacy—video teleconference with or without video (Zoom, Teams, etc.) or via telephone. We did not conduct in-person interviews. At the conclusion of each interview, we asked participants to suggest others that might be interested in participating in our research. All participants provided verbal consent to have their interview audio recorded (see Appendix B). Each participant was interviewed by two or three researchers to allow the primary interviewer the opportunity to engage the participant while the remaining researchers noted participants' comments to be revisited or elaborated upon. Subsequently, all interviews were transcribed and coded.

## 3. Interviews

Navy personnel (active and reserve military and civilian) were recruited to participate in virtual interviews via an email (see Appendix A) describing the duration of the interview (45–60 minutes) and the purpose of the study. Prospective participants were informed that interviews would be anonymously identified with an alphanumeric code (such as P1, P2, P3, … P13 to indicate Participants 1, 2, 3, … 13) and were asked to provide verbal consent (see Appendix B) to have their answers audio-recorded and transcribed for our study. Thirty-eight potential participants were invited to participate in the study, of which 13 volunteered and were interviewed. Those who agreed to be interviewed were informed that the interviewers would solicit their feedback and opinions based on their experiences with the adoption of mobile learning technology in the Navy.

Similar to Hall and O'Connor (2018), we adopted the style of our interview questions (see Appendix C) from Aten and DiRenzo's (2014) study, *Assessing the Potential of Virtual Worlds for Navy Training and Education: Cognitive Learning Processes and Outcomes in the Virtual Schoolhouse (VSH)*. We asked participants to explain how policies are affecting the use of mobile technologies and their organization/

group's process for accepting technologies. Participants ranged in diversity in age, ethnicity, gender, and rank and spanned a broad array of naval experiences and backgrounds—both technical and nontechnical (see Appendix D). Of the 13 Navy personnel interviewed, six participants were enlisted and consisted of the following ranks: one E-1 to E-4, three E-5 to E-6, and two E-7. The age range of enlisted participants were zero 18–24, three 25–34, three 35–49, and zero 50+. There were five officers, which consisted of the following ranks: three O-1 to O-3 and two O-4. The age range of officer participants were zero 18–24, two 25–34, three 35–49, and zero 50+. Ten participants were active duty, and one was a reservist. There were two civilian participants with the following age ranges: zero 18–24, zero 25–34, one 35–49, and one 50+. There were seven female participants and six male participants. The ethnicity of our participants consisted of six Black/African Americans, three Hispanics, and four White/Caucasians. Each participant interview lasted 45 to 60 minutes (Hall & Connor, 2018).

## D. DATA ANALYSIS

We transcribed and coded the 13 interviews, working through the transcripts to identify themes and generate a mid-range theoretical explanation that answered our research questions. Coding involves segmenting the data and labeling each segment to identify what the data are about (Creswell & Creswell, 2018; Thornberg & Charmaz, 2014). We reduced the data through our initial read and coded only data relevant to our study. The themes and patterns that emerged from coding the relevant data allowed for the interpretation of the results. The data analysis process began with transcription and ended when our theory thoroughly explained our data.

### 1. Transcription

Upon completing each interview, we discussed new and reoccurring ideas and identified any need for additional sources. We then submitted the audio recordings of interviews through TaskIt (a productivity application) for transcription. The transcriber captured both interviewers' and participants' words verbatim to ensure no data were lost in transcription. We used Dedoose data analysis software to code the data. Each transcript

in Dedoose (called a media) used the same pseudonym as the audio files. For example, the transcript of the Participant 1 interview was named "P1."

### 2. Coding

A critical part of the qualitative research process was coding the transcribed data. Coding allowed us to identify data meaningful to our research question and organize data into themes for more straightforward interpretation. We coded interview data using both a priori and emergent codes for participants' concepts of PU and PEOU. We generated a priori codes based on the literature review on mobile learning and PU and PEOU under the TAM framework. Additionally, we selected a priori codes from the MyNavy Learning functional requirements document (an NETC working paper). Emergent codes were developed when patterns appeared in the participants' responses and we conducted data familiarization.

Thornberg and Charmaz (2014) stated that coding is not a linear process. They identified two phases of coding, initial coding and focused coding, and proposed that researchers move between these two phases throughout the data analysis process. In this study, we reviewed and recorded our initial impressions of the transcribed data and codes separately, then compared notes and memos and reorganized, consolidated, or expanded to eliminate redundancy and categorize newly discovered themes. We engaged in both initial and focused coding for this study to develop and refine codes and themes.

#### *a. Initial Coding*

Initial coding involves looking at all the data—line by line, paragraph by paragraph, or by any other strategy to compare data—assessing critically and analytically what participants are saying and assigning a code reflective of what the data indicate (Thornberg & Charmaz, 2014).

We read each transcript to gain an initial understanding. Then, we focused on participants' experiences and responses. We engaged in data familiarization of all the interviews and then selected only data relevant to the research questions for coding. As previously indicated, we developed a priori codes from the literature review and the

theoretical framework underlining this study, the TAM. These codes were used in initial coding where the code fit the data. However, an essential part of this process was acknowledging emerging codes and using those new codes to capture significant details in the data. At the beginning of the process, 47 codes were generated under two theoretical themes, PU and PEOU, based on the literature review. We later modified these codes to reflect the data collected.

#### *b. Focused Coding*

Utilizing the initial codes, we reanalyzed the data with greater focus. In this focused coding, process codes were refined, relabeled, or removed. Additionally, we re-coded, separated into different codes, or combined codes as we continued reading through the data. Re-coding was essential in the process to ensure participants' views were captured as accurately as possible. Additionally, Graduate School of Defense Management advisors assisted with interrater reliability of the codes by helping us to clarify and define individual codes and overall themes. We added three themes to PU and PEOU based on new data from interviews: mobile learning self-efficacy (MLSE), device preferences, and organizational policy. Our coding resulted in five thematic categories. The final categories and subcategories of codes used for this study are provided in Appendix E. These conceptual categories allowed us to compare the data collected to existing knowledge. In some cases, new categories influenced us to conduct an additional literature review.

### 3. Interpretation

The focused codes provided the themes on which we would report our findings. At the point in our data analysis where we were not discovering new information in the raw data, we began to focus on explaining the contents of each category of codes. In this process, we looked at the big picture in terms of how each category, identified in Appendix A, would assist us in answering the research questions.

This process culminated into the results presented in the next chapter. Figure 6 is a depiction of our data analysis process. In Chapter IV, we present our final model, using categories and subcategories to provide a rich interpretation of the data collected.

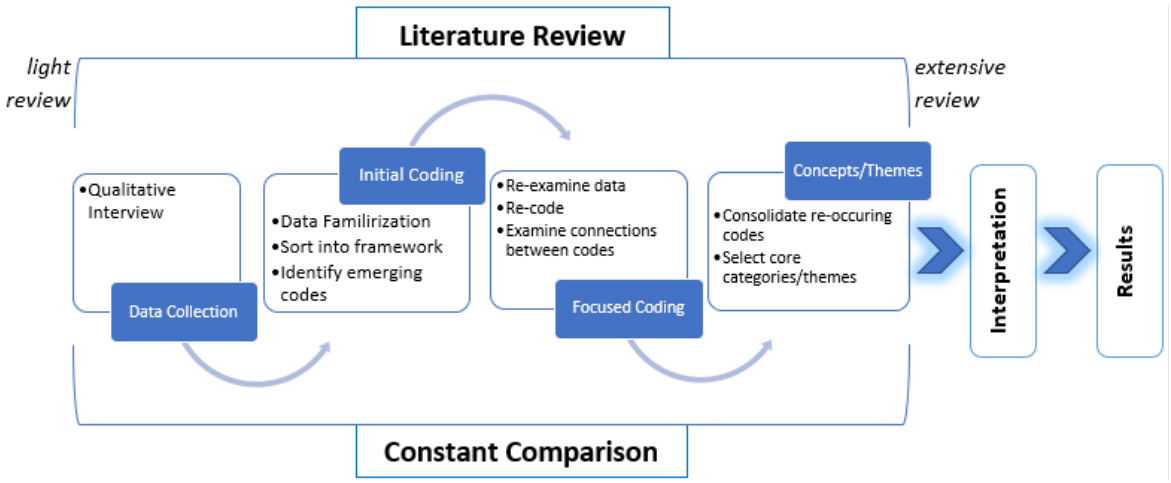


Figure 6. Qualitative Data Analysis Process

## E. SUMMARY

The goal of this chapter was to outline the research methods we used to answer the research questions. A discussion of the research approach, data collection procedures, and data analysis procedures outlined the research design and methods. We collected and analyzed qualitative data, relying on grounded theory analysis techniques. Semi-structured interviews allowed us to develop a framework explaining mobile learning adoption in the Navy. Chapter IV provides the results of this study, which was conducted using the methodology outlined in this chapter.

# IV. RESULTS

This chapter contains the results of the study conducted to answer our research questions. The study results are based on 13 semi-structured Navy active duty, reserve, and civilian personnel interviews. In this study, the TAM was used as a framework to provide structure for assessing the participants' perceived value of mobile learning technologies. Data collected was initially organized under two main themes, *Perceived Usefulness* (PU) and *Perceived Ease of Use* (PEOU). However, emerging data allowed for the expansion of our themes to include three additional themes, *Mobile Learning Self-Efficacy*, *Device Preferences*, and *Organizational Policy*. Therefore, our findings will be described in the aforementioned organized themes and subthemes as presented in our Data Analysis section of Chapter III.

## A. PERCEIVED USEFULNESS

Davis (1989) defined PU as "the degree to which an individual believes that using a particular system would enhance his or her productivity" (p. 320). In line with current research, our findings show that PU is an important factor in the acceptance of new technologies. Our study identified three factors relevant to PU: productivity, career information management, and the attainment of skills and competencies.

### 1. Productivity

In our study, productivity was an essential driver of participants' perception of the usefulness of mobile learning technologies. Productivity was defined as the balance of factors and resources that enable maximum output in performance with the least effort. Participants' responses underscored three factors relevant to the effective use of mobile learning technologies for maximum performance: accessibility and availability, compatibility and relevance of technology, and maintainability.

#### *a. Accessibility and Availability*

Accessibility and availability were collectively used to code comments that described how easily resources could be obtained and readily used for task completion (both job and

learning tasks). Participants identified two factors related to the availability of training: flexibility and ease of access. Some participants preferred the flexibility of portable learning materials that allow them to access training material away from a computer without requiring a common access card (CAC). In addition, most participants agreed that the timely accessibility and availability of resources are critical to task completion.

Ease of access issues included resource constraints typical to a shipboard environment and how this might limit shipboard Sailors' opportunity to benefit from a mobile learning environment. Participants thought that the technological infrastructure on some ships might limit Sailors' access to mobile devices, including bandwidth issues and the availability of data services needed to access training content. For example, one Sailor with shipboard experience expressed that the use of mobile learning technologies would be ideal for shore Sailors only if connectivity was robust: "Well, it'll definitely be easier for shore-going commands because they have access to all the cellphone reception, so, you know, ships won't be able to kind of participate in that." There were other comments on the accessibility and availability of resources on a ship that supported this statement. For example, one participant expressed frustration that training requirements were communicated before the start of liberty with insufficient computers to complete the training in a reasonable amount of time. Another participant commented that the internet is not always available to those who did not have essential duties.

There were similar concerns for Reserve Sailors. On a drill weekend, access to enough computers to complete training is a challenge. While using mobile devices might aid productivity on these weekends, one participant noted the lack of adequate connectivity: "Not everybody brings their personal laptop because it's a hassle to get connected to the Wi-Fi, and the Wi-Fi is not the best when we're all trying to use it at the same time." In addition, command requirements for Wi-Fi access were seen as excessive.

#### *b. Appropriateness and Relevance of Technology*

The appropriateness of mobile learning technologies in the context of the work environment is a key determinant of PU. Participants with shipboard experience noted the difficulties of mobile learning in an afloat environment: "It would be hard to do mobile

training if you're on sea duty," "I love the technology idea. It works great when you're not underway," and, "If I was on the flight deck, I don't think that would have worked out." However, some participants offered that preloading devices or content that would not require data services or other connectivity might be helpful.

Similar to compatibility is the concept of *relevance of technology*. Relevance of technology was defined in this study as the degree to which training content delivered through mobile technologies could match users' training needs. This definition of relevance of technology was adopted from Hong et al.'s (2002) study on user acceptance of digital libraries. One Sailor with equipment maintenance duty on a ship identified as a visual learner and offered that having a mobile device with maintenance training material would help her complete her tasks: "I'm more of a visual learner, so I will have to see what's going on, and then have hands-on, and then be able to do the process." This participant also concluded that in the contexts of her job tasks and working environment, a tablet or a phone would best meet her needs but that a laptop is not portable enough when moving through ship spaces: "No laptops. Maybe a tablet. It all depends on the size. A phone could work. … A laptop is too big. It would be too big to carry around." For this participant, the mobile device requirements were contextualized and required a large enough screen to access maintenance instructions, videos, or pictures of tools and equipment parts and small enough to comfortably carry with her maintenance tools. Additionally, in this case, the participant expressed a desire for government-issued devices while afloat that are individually assigned, stored with maintenance tools, and checked out as needed.

One shore-based Sailor shared similar sentiments concerning the appropriateness and relevance of technology in their job performance. This participant, however, was at a shore command and was excited about using a personal tablet or phone in the field when completing building construction tasks: "That would be the greatest thing to me, I mean if I could have my references on a tablet or my cellphone and I could pull it up. … I actually lay this building out correctly." For another participant, the important context of use was related to the type of training. This participant thought that training that required multiple types of interactions with the training material could not be effectively delivered on the phone:

> I don't have a huge screen. … If you want me to entertain multiple things at once, … like on that insider threat training—you get this huge dashboard and it's got like all the different things. I don't think that would work too well on my phone, so you'd have to work with the designers to make that work.

Finally, a laptop was the appropriate mobile learning technology for one participant who valued the ability to take notes electronically while learning. For their training needs, a laptop offered the ability to multitask by using two windows on the same screen. In all of these cases, you can see that the appropriateness of the technology is dependent upon the context of use—where it is used and how the learner must interact with the material to make it useful.

#### *c. Maintainability*

Maintainability is the final factor of productivity that emerged. Issues related to logistics of use, updating, damages, and loss of productivity surfaced in our study. One participant described the multiple challenges of government-issued mobile devices and the logistics and downtime involved to keep the devices updated. The participant stated,

> If you have a Navy-issued device, they're going to have to go through that process of getting it turned back in and updated and protected. … If they're on a ship or a boat, they're not going to be able to take it home. … Who's going to inventory it? Who's going to store it? What's going to happen when you have down time [because you can't] do necessary updates?

Another participant's maintainability concern was possible damage to government-issued devices and the expected responsibility: "The thing that alarms me: damaging the phones—or tablets. … I think there's a certain level of responsibility that you have." Maintainability for many participants was an important factor in how they perceived the usefulness of any mobile technology.

### 2. Career Information Management

Being able to manage one's career and educational path is essential to users' PU. Our results indicated that junior Sailors are often not aware of the training needed to advance their skills career. For example, participants commented that there was "no clear progression" and "no blueprint to help build you up in the ranks and leadership." At least one officer who

managed enlisted Sailors confirmed this finding. This participant offered that career progression and training requirements are not transparent and that junior Sailors' success is dependent on whether their leadership is successful in their own career path. One mid-rank enlisted Sailor thought that junior Sailors are often not required to learn beyond their job requirements. As a result, while information for annual general military training (GMT) is provided unsolicited, information for job-related training beyond the basics must be initiated by Sailors, and some do not know what they need:

> Some Sailors honestly do not know. … If it's something dealing with your job, there are really no more requirements except that you did your ratings school. Unless the command wants to send you to school—they do suggest that … you really don't need anything else.

The importance of information management for career advancement is evident to both Sailors and officers managing Sailors. One participant provided that an ideal solution for Sailors to personally access and manage career advancement information can be a mobile learning solution. This mobile solution should include the ability to track their statistics for rating (job/career) advancement, outline study details, and track completion of all the baseline topics.

The data showed that different types of users have different needs for career management support. For example, one civilian participant would prefer a CAC-less application that outlines training required, completed, and due. Similarly, a senior enlisted Sailor suggested a system where all Sailors had access to rating information, including links to requirements for their job field. On the other hand, a junior enlisted Sailor valued access to not only view but update career information records. Finally, one officer participant thought that in a mobile setting, Sailors should be provided with a checklist for career advancement and incentivized to meet those checkmarks. This participant offered that this could also be a force reshaping tool where only the right Sailors (those who complete the career advancement tasks provided) would advance.

Finally, one enlisted participant spoke of Sailor 2025 with enthusiasm for how responsive Sailors were to the opportunity to continue their education and take ownership of their training, career, and job performance: "It kind of replaces like the one-and-done

classroom training. … It is something that you, basically, you take ownership and you do it on your own. … Sailor 2025—you can get faster help through MyNavy [Portal] and so it's good."

### 3. Skills/Competence

The final category of PU is related to the development of specific skills to achieve competency. For this study, *skills* were defined as the type of abilities a person needs to perform a job. *Competency* was used in the context of successfully applying a set of knowledge and skills on the job. To progress towards specific job performance goals, naval personnel need to demonstrate relevant competencies. Participants' interview responses highlighted three factors relevant to mobile learning technologies and the attainment of job skills and competencies: learning objectives, lifelong learning, and blended learning.

#### *a. Learning Objectives*

Learning objectives that are clear and relevant drive learners' perception of usefulness regardless of the technology. Our study defines *learning objective* as an adequate description of the skills and abilities obtained from a learning session to determine its usefulness to their job performance. Most participants identified annually assigned GMT and, to a lesser degree, job-related training as the types of training offered by the Navy. While participants differ in their responses to why the Navy assigns training, they could communicate the usefulness of most training assigned. For example, one participant stated, "The trainings that we were given was basically to make subject matter expert[s] … or be able to perform the job that we were designated at that time."

Participants expressed that some junior Sailors do not have enough information or an adequate understanding of the learning objectives to make a connection to their job performance or career. For example, one mid-rank Sailor (E-5)—referencing Navy Credentialing Opportunities Online (COOL) and United Services Military Apprenticeship Program (USMAP)—commented, "I'm familiar with Navy COOL. I'm familiar with USMAP. But it's not always I guess so cut and clear as to what those programs are or what they can do for you." Our study also found that for some participants who understood the

learning objective, relevance to job function was necessary to acquire the intended skill. To this point, one participant commented,

> I don't classify any information, … but yet I have to do classification training. … Some of those tests are quite complicated and I fail them all the time: one, because I never do these actual tasks and then, two, because it's too short a period of time for me to master how to classify information.

Additionally, often the design of the material leads to rote answering and does not address the specific learning objectives. This is especially true when the training is familiar, as in the case of some annual GMTs, where some participants admitted to completing the training assessment multiple times for a passing grade rather than completing the course with learning intentions: "Why am I doing this exact same training that I did last year? It's identical. I'm just clicking through."

However, there were a few instances where participants identified situations in which the learning objectives aligned with the delivery. For example, one participant thought that interactive training such as plays and videos that mimic real-world scenarios are more effective in connecting the learning objective: "It was like a play, … and it talked about consent. … Actually seeing it play out in real life, … okay. So that's what consent is." Another participant thought the use of video scenarios for counterterrorism training helped him adapt the right behavior intended by the training:

> They're kind of like the scenario ones. … If somebody breaks in your room, do you get on the floor or do you like fight back? … It kind of helps you overcome bad training you've had in the past and kind of remind [s] you of what you're supposed to.

Alternatively, a participant preferred in-person GMTs moderated by a "good" presenter who is knowledgeable and interested in sharing the information and can help learners connect to the learning objectives: "They made it fun and then engaged the crowd. … I think it affects the content, because if you can connect the main points … it makes us remember more."

### *b. Lifelong Learning*

Learning objectives that are tied to lifelong learning goals are especially important to our participants. For our study, the term lifelong learning describes intentional activities undertaken throughout life to acquire the skills and competence needed to adapt in a changing environment. Several participants emphasized that skills can be lost if the opportunity is not available to practice consistently. This supports the idea of using mobile technology to support anytime, anywhere learning. In addition, it is important for learners to be immersed in their training to develop their ratings. One participant with experience managing enlisted Sailors in a shipboard environment noted the importance of having the training be specific enough to enlisted Sailors' basic job functions.

Another participant proposed that mobile learning technologies can extend the availability of locally developed courses, increasing opportunities for personnel to engage in training materials of interest constantly. For example, if a subject matter expert (SME) created a successful course locally, whether for ratings or civilian licensing, there is an opportunity to provide access to the entire Navy through mobile learning.

### *c. Blended Learning*

Finally, blended learning—where formal and informal learning, training and education, and personal development and operational duties are seamlessly integrated—is key to meeting the Navy's learning objectives. The Personnel Qualification Standard (PQS) program is one type of informal training emphasized by participants. Personnel completing a PQS engage in assigned reading material and/or practical exercises and on-the-job training if required and obtain a signature from SMEs once competency in the standard can be demonstrated.

One participant noted how the PQS training approval process can be enhanced through the use of mobile technology: "Your PQS could now be in an app, where you don't have to have paper. … Signatures can get done literally as you go through it, and you can't fake that." This participant emphasized the ability to electronically track PQS progress, where learners and leaders can monitor progress through the application (app). Another participant agreed that incorporating mobile learning technology into PQS training could provide

additional refresher courses to be incorporated into the traditional PQS process. Personnel could get hands-on and classroom training from an SME but can watch videos and look up content as a refresher.

Similarly, one participant with Navy instructor experience also offered that repetition is vital in learning any skill, and mobile technology can incorporate practical assessments or be used as a point-of-need refresher: "If I could have videotaped myself doing the skill, then they could watch that at any point in time. … They're going to be able to score so much better, and that makes us a much more ready force downrange." Additionally, one participant agreed that some skills are best learned on the job, with mobile learning complementing classroom learning and expanding the opportunities for those who do not have access to a classroom.

## B. EASE OF USE

In a system that is easy to use, the user is able to accomplish specified actions free of effort. Our findings show that ease of use is an important factor in the acceptance of new technologies. These factors include learnability/understandability, effectiveness, efficiency, and satisfaction.

### 1. Learnability/Understandability

Of the four key factors in ease of use—learnability/understandability, effectiveness, efficiency, and satisfaction—perhaps the most pertinent to implementing and adopting mobile learning technologies in the Navy is learnability/understandability. Several participants reported that learnability/understandability is critical in adopting mobile learning technologies: "My perspective of simplicity … it's just easy to understand," and, "If … the simplest person can understand it, of course everyone's going to buy in. If you make it too complex, why would I want to get into it?"

This sentiment was echoed in the confusion experienced by several participants while engaging with mobile learning technologies that were not intuitive. One participant shared an experience that they believed most people using video teleconference platforms (Zoom/ Teams) during the pandemic could relate to: "How do I turn the mic on? How to turn the mic off. Am I on mute? … Then I realize that I'm not on mute." Another participant reflected on

their frustration with the absence of understandability in the system: "It gives you no functional understanding in the system. … The objectives are not met, and you are … force fed through button-click-ology with no reference or understanding of what you're really doing."

Other users reported decreased likelihood and willingness to accept a new platform if they found the mobile learning technology difficult to understand and learn because the context or content was not easily recognizable or intuitive. One participant explained, "I don't think TWMS [Total Workforce Management Services] is very user friendly—it's not my favorite online learning platform." One instructor shared their dilemma with a system that was not easy to learn or teach, especially when training was not provided: "I'm the guy who has to learn it, but I'm the one that has to teach everybody how to use the darn thing, so it would be nice to have training. … We have to learn it on our own." However, one participant suggested using mobile apps to improve learnability/understandability: "Just to do maybe little apps … because a lot of students … have study apps … that can kind of help you retain … information."

Learnability/understandability was further assessed by users' access to technical support at the point of need while interacting with the mobile learning device/platform and by visibility (ability to locate training at the point of need).

#### *a. Technical Support*

In addition to understandability in technology, participants expressed a strong desire to have access to live support at the point of need. Our participants suggested the inclusion of technical support to address any questions or concerns that may arise while utilizing a mobile learning technology: "I expect there to be an expert … that knows what they're doing," "It should have live support, where it has a chat function, and if I as a learner have a problem, I can get … live support [for] the product [,] … mobile device [,] … software, or … training module." "I think that would be highly effective."

Another participant suggested a similar but slightly different type of technical support than chat or phone—an online forum managed by a dedicated staff:

> I think that maybe a forum would be a little bit better … instead of … an email track going back and forth. … You put in the question, and [dedicated staff] spit out the answer almost immediately. We should be able to do that.

#### *b. Visibility*

Although similar, one of the most critical aspects of learnability/usability in a mobile learning environment is being able to easily locate what is required. First, several participants noted the importance of easily locating the training. This includes using a singular system, including a robust search, and providing easy navigation. The lack of visibility is an important part of perceived usability: "There's a program … that we can get on and track our own training. … It's absolutely user unfriendly. … You have to know exactly which course you need to take. … You can't even search. The search in there is absolutely horrible." At the minimum, mobile technologies should provide other resources to aid users, including "leaders that know the resources … not just knowing the information, but … knowing where to point people to the right resources."

Second, visibility was closely tied to the desire for an integrated system and single location in which all training requirements were available, accessible, managed, and tracked as explained by these participants: "I would like to see maybe less systems to log into. … It's always … you log into this system or you log into this system and you have mismatching information. … As an organization, we could maybe narrow down our systems." Again, the importance of having a single source for training is critical: "It would be nice that all training filtered through one portal and filtered up and back instead of having to go through multiple different sites."

### 2. Effectiveness

Effectiveness was another important factor our participants reported on how they perceived the ease of use of mobile learning technologies in the Navy. To measure effectiveness, which we defined as accuracy and completeness of goals (Bevan et al., 2016), we looked at the following areas: interactivities (ease of interaction with other learners, educators, and SMEs), operability (ease of using controls/user interface), relatedness (relevance to the tasks), and self-regulation (self-monitoring, self-managing, and regulating time).

### *a. Interactivities*

Interactivities were a critical element of effectiveness in ease of use and were evaluated under two social interaction subcategories—engagement and collaboration (in groups or peer-to-peer). One participant noted the overall importance of supporting interactivities in mobile learning technologies: "So, anything that's interactive, anything where we can voice our concerns or voice our opinions on, or just like feel a part of, I think is always effective training."

### *b. Engagement*

Engagement is an important factor in perceived effectiveness. Engagement is defined as the ability to maintain user interest and can include interactive games, plays, and videos. Several participants noted how users' attention and interest could improve the effectiveness of knowledge retention. As one participant noted, "That was really good. … We also had videos. … It's a game to us, so it makes it more entertaining. … For the younger Sailors … it's fun."

### *c. Collaboration*

Collaboration is an important capability in PEOU in mobile learning. Collaboration includes instructor and student interactions and peer learning. Interacting with instructors and peers makes the use of the technology more enjoyable and therefore more effective. Several participants expressed the potential impact of collaboration in a mobile learning environment.

One participant explained clearly the benefit of learning from peers during mobile training and education: "It's great when you can … tap into [the] experience from another student that has a better understanding. … So, yeah, I think peer-to-peer learning is just as good." Another participant noted how interaction with peers would be more effective in a mobile learning environment due to the culture and rank structure of the military: "I feel like peer interactions work just as well. … For some reason, Sailors are a little bit more comfortable with talking to each other than they are around rank." Similarly, an instructor shared the benefits of collaborating with instructors: "As a group training, it's effective

because if somebody doesn't understand something … I can give them my point of view … and we get all the training done together."

### *d. Operability*

The ease of using controls and the system interface is another factor impacting perceived effectiveness. Some participants noted that operability created a more efficient mobile learning experience. For example, one participant shared the importance of clarity in the use of multimedia: "A computerized voice is delivering the training. It's either monotone or the signal is bad. We cannot really hear what they're saying." Another participant noted how the screen size could affect the usability of mobile learning technology and influence adoption: "I think with the phone … it all depends on the size [,] although … some out there are big. … [Even if it] does have a small display … if you turn it to the side, I think it could still work out." Similarly, one participant offered a suggestion to improve operability by making learning modules cross-platform compatible: "When you log on to a site it'll have an option to view either the desktop site [which is] completely different from the mobile [site]. … I just think that having something like that to fit the program on a mobile phone or a tablet would be highly effective."

### *e. Relatedness*

Relatedness is a significant factor in the effectiveness of mobile technology. Relatedness, as opposed to usefulness, is about how well the technology addresses the specific task at hand. When the technology is appropriate to the task (for instance, using a phone to look up a definition), the activity captivates the user's attention and motivates them. This relationship between the relatedness of the task and the impact on attention was noted by several participants: "When I don't see a relevance to my job, I don't put that much attention into it," and, "It's just like, hey, here's this thing. … You figure out how it applies to what you do." Likewise, another participant shared their positive experience with training they received overseas that was specifically related to their duties and responsibilities: "It taught you what you needed to be successful [,] … things that I'm likely to use. … It was something that I wanted to pay attention to." Another participant noted how relatedness also impacts motivation:

> You hear something about a corpsman and automatically your ears perk up … because you can relate to it. Not only can you relate to it … you can … put yourself into it and realize … this is why the Navy is having me do this.

### *f. User Control*

User control is another important factor in measuring effectiveness of mobile technologies. Many participants expressed a strong desire to have the flexibility of self-regulated training that they could conduct at their convenience: "With doing it from mobile, you're able to do it anywhere at any time." Another participant shared a similar view of their ideal self-regulated mobile learning experience:

> Let's say I'm just resting for a weekend, but I have 3 hours to spare. I can get on there … on my own time [,] … finish some training or … look ahead to see what I would need in the next week or … next month.

One participant expressed how autonomy in a mobile learning environment could eliminate stress: "With COVID everybody is having burnout mentality. … We're tired … so… you're giving the Sailor time to choose to do it on their own … instead of having to be at work. …Go sit at the beach. …Take the work atmosphere out of the training."

Several participants noted the importance of freedom of navigation based on individual place, path, and/or pace identified by NETC (2021). One participant mentioned that autonomy afforded them the opportunity to take their time: "It's self-paced. … You get to take time and study a little more." Another participant advocated for a feature to accelerate their learning experience: "Oftentimes … I have to go at the video's pace. … If I can just test out … I don't need all this background information." Participants without access to a computer at work, or those working in demanding environments such as in health care or afloat, expressed the importance of being able to self-regulate training to save time and/or focus on their primary duty. One participant shared their scheduling dilemma: "Now I got to see my patients or go do my training." And another relayed how allowing user control can eliminate this dilemma: "It allows me to see what's due and not wait on somebody to tell me at the last minute, 'Hey, you got to do this training.'"

### 3. Efficiency

Efficiency is the third factor in how our participants evaluated ease of use. Efficiency consists of cognitive effort, physical effort, and timeliness. Participants' criteria for evaluating cognitive effort were based on the following areas: integrated (centralized location/one-stop shop), personalized/customized, and trackable. Physical effort was assessed based on portability (mobility). Timeliness was based on the users' perception of how easily retrievable the training is.

#### *a. Cognitive Effort*

For mobile technologies to be efficient, they need to reduce the amount of "think time." This is known as cognitive effort and is dependent on having an integrated platform, personalized content, trackable interactions, and consistent materials, styles, and delivery.

##### (1) Integrated

In conjunction with self-regulated training, accessible anytime and anywhere, most participants in our study expressed a great desire for a centralized platform where all training was integrated as a one-stop shop. The urgency of such a consolidated system was echoed in these participant statements: "There's too many portals to go and do training," and, "If I had one spot where I know all my training is going to be and I don't have to log on to six different sites to complete my training, or I know what to do in one site, then that'd be awesome."

However, one participant reflected on how their experience with an integrated Navy mobile learning platform was easier to use: "They're trying to make it a little bit easier with MyNavy portal now, with the quick links and the one-shop stop [one-stop-shop] to be able to … get to all different types of websites." In contrast, other participants reflected on how their experience with the absence of an integrated Navy mobile learning platform created confusion many could relate to: "If you're checking one system, they might see that you're up to date, and then … it doesn't talk to the other system. Then the training officer [knocks on your door and says:] You owe me this, and you're like, I owe it right now?"

To help alleviate some of the frustration, several participants offered suggestions to make integration of Navy mobile learning technology more efficient. One participant

recommended interoperable systems: "When you make a change in your training record … it will trickle through all the necessary systems." When asked about privacy and security concerns with a centralized mobile learning technology platform, another participant noted: "Any of that information is readily available. … Somebody has access to all your information. … So it being in an app, to me, it's actually more secure." In comparison, another participant noted how mobile apps are already being used to access medical data: "Everything that I've ever seen for [medically] is on an app or website I can access from somebody's Wi-Fi."

(2) Personalized/Customized

Participants expressed a strong desire for a personalized/customized mobile learning experience. Responses were given based on the necessity to have the ability to tailor, adjust, or adapt based on individual needs, goals, preferences, strengths, and weaknesses. Several participants noted the importance of personalization/customization in a more efficient mobile learning technology experience as echoed in these participants' statements: "If it's tailored to me … I can log on my phone. I can look at what I need to look at, do what I need to do, and then I'm done." One participant suggested personalized/customized training based on individual learning styles, strengths, or weaknesses: "Other people might literally not learn well that way. … Are these … trainings … done in different formats for people who prefer different learning presentations?"

(3) Trackable

Another major factor in efficient usage of Navy mobile learning technologies for training and learning is the ability to accurately (and independently) track training requirements and progress. According to the literature, when a system stores and monitors user progress throughout their learning continuum it is trackable (NETC, 2021). The current process of tracking training through a third party such as the unit training officer is dependent on individual supervisors: "Generally, the local training officer is the person who sends me all my training. … That's how I know what training that I am required to do."

However, Sailors aboard ships often experience additional delay and frustration when the inability to track training impacts their personal life, as echoed by this frustrated participant:

> Shipboard, you'll normally get a message from the TRAINO [training officer] saying … it's due like yesterday or it's due today and, you know, liberty is going to be held up if you don't complete your training. So, shipboard it's last minute. It's like yesterday last minute. it just seems like it doesn't filter through until last minute for shipboard Sailors.

Another participant shared how tracking their own training requirements on a current system was limited by the absence of an alert/notification system:

> When I can remember to go to the dashboard … I will look at what my training is. … But I basically wait for someone to alert me ahead of time or to kick my butt and say: "You didn't do these things. Go do them and here's the link."

One participant suggested a method to track training while afloat with a mobile application:

> If the PQS process requires … signatures from different people … an app would make that … easy. … If … they were able to … electronically sign … I could bump my signature to your phone because we're together [,] … upload it to the cloud, and now I don't have to worry about this binder.

According to our participants, being able to track your training requires a mobile technology that is "extremely easy to use. As soon as you get in there, you can see exactly … what the issues are. It's very easy to track." "With technology you're able to have these programs and these visual aids … that logs that you have done this training. … And then it says … you've completed this training."

(4) Consistency

Consistency impacts efficiency by cutting down the amount of mental effort required to use a mobile technology. Consistency includes consistent delivery, standardized products, and reliable technology. Multiple participants expressed the need for consistency in training materials, style, and delivery independent of instructor experience or users' location/ environment. Inconsistencies in training was a concern for career progression and preparedness. Frustration shared by our participants was echoed in these comments: "One of my biggest problems with our combined online learning methodologies is that there's no standardization." "It's product to product. Each product is different. … They require you to

get 100% on something. … Nowhere did it say at the beginning of this that you had to get 100%."

These delivery inconsistencies also exist between OCONUS and CONUS localities and whether a servicemember is active duty or reserve. One participant who had served overseas shared, "Training varies from overseas to CONUS drastically, but it also varies duty station to duty station." A Reservist in our study noted, "Active duty [does it] on a daily and … have many different ways of doing things. … Reservists, sometimes we see the training only once a year." The bottom line that participants in our study relayed to make training more consistent was offered in this suggested solution: "Whether it's the in-house training or if it's Navy eLearning, the thing gets set up the same."

To further emphasize the need for consistency, several participants identified the difficulty of "having consistent training [,] … consistent delivery of the information. … When you're trying to find resources … I expected it to be there, but I get … this error message," and, "I'm just a little less patient … when things are supposed to work a certain way and they … don't, then I find myself less flexible." These difficulties reduce the amount of time spent learning.

#### *b. Physical Effort*

Physical effort is the second component to efficiency. Physical effort includes portability or mobility—the freedom of movement and handling while standing, sitting, or in transit as it pertains to handheld mobile devices (Aten et al., 2018). Portability is highly dependent on the context of use. Portability on the ship is different than portability at home. One participant suggested how the use of a mobile app on a phone could help Sailors on ships be more efficient and aid in adoption: "You can make the process easier in an app … especially for people who are trying to track and make schedules … like bridge watches. … That can all be on your phone."

The nature of the task also comes into play when assessing portability. As one participant explained, "Everything is now via cellphone. … I can look at my medical record [,] … make my appointment [,] … watch movies. … So it just makes sense that I would have access … to complete my training." Another participant noted how phone portability lightens

the physical load a servicemember has to carry: "It's easy to carry around. You don't have to worry about having your action backpack for anything [or] another heavy load while you're carrying your tools to go wherever you need to go."

A frequent overseas traveler in our study described how portability impacted the ability to share information: "It transfers from [my] workstation. … Then I'm able to download … PDFs [portable data files]. …Then I can save those … to my phone … and my laptop [:] … emergency contacts [,] … embassy locations [,] … country clearance paperwork [,] … travel visa." Similarly, a Reservist shared how their experience with increased portability with the use of a CAC reader—designed to work with a mobile phone—was highly effective: "One time, I had to quickly … download an LES [leave and earnings statement], and [it] was very convenient for me to take out my CAC card reader and use it on the device."

#### *c. Timely/Easily Retrievable*

Several participants noted the importance of mobile learning technology being timely/easily retrievable as an important indicator in mobile learning technology adoption. One participant reflected on the efficiency they experience with the convenience and timely access to mobile learning technology created while stationed overseas; they appreciated "not having to fly somebody down [,] …worry about the logistics. … I think it was just as efficient to have that person virtually than to have them physically there—for some training." In contrast, other participants reflected on the inefficiency they experienced with not being able to easily retrieve what they needed in a timely fashion:

> When it comes time to use it, there's actually no easy way to go back. … If you need a refresher or even like a quick one-pager, … you literally have to sift through … instruction, web pages, phone numbers that are disconnected, emails that don't work, people that don't respond.

Another participant shared their thoughts on solutions to ease frustration associated with a non–timely/easily retrievable system: "As long as we have something … that's speedy to use—literally, you just plug it and then you go [,] … [one] that's more convenient and … less frustrating, where people can just log on and have a password."

### 4. Satisfaction

In our study, satisfaction was an important driving factor in Sailors' perceptions of ease of use and willingness to adopt a new technology or revert to old forms. Participants' satisfaction included three primary factors—whether or not the technology was perceived as enjoyable, whether or not it worked predictably, and how strong the users' motivation was to add in the technology to their workflow.

#### *a. Enjoyable*

Enjoyment was an important factor in perceived satisfaction and consisted of interactions with mobile learning technology that met the user's needs and expectations. One participant noted how engaging with mobile learning technology in a fieldwork environment is a good thing: "That would be the greatest thing to me … if I could have my references on a tablet or my cellphone and … see how I can actually lay this building out correctly."

Several participants described how their training experiences were enjoyable and engaging and improved learning:

> His training … was short. … Objectives were very clear. … Information and … delivery stimulated [my] thoughts, and [I] felt an immediate tie-in with it. It progressed quickly from point to point. … The evaluation on the information was poignant and it was relevant. … It was a well-thought-out training.

In contrast, another participant shared how the lack of enjoyment reduced their engagement with the material: "It was [originally] a really good training because it was new … interactive … fresh. … Now I've seen it … going on 4 years, and it's just like, Ugh, this again?"

#### *b. Motivation*

Motivation, especially in younger Sailors, was echoed as a major component in satisfaction and in adoption. When asked what motivates Sailors, participants offered three key factors: novelty, leadership engagement, and incentives.

One element that was overwhelmingly shared was the ineffectiveness of repeating the exact same training: "We're tired of seeing the same PowerPoint … and I don't think that it's effective anymore." One participant suggested intensity and pressure is imperative for

motivating Sailors: "If you don't pass, you don't pass. …We only want the best. And that keeps you in a high-pressure environment."

Other participants believe engaged leadership was another important factor in motivation to adopt mobile learning technology across the organization. Participants explained, "You have to have people that have an interest that are in charge that are interested not only in the mission but in the people that they're growing to accomplish the mission."

Still other participants shared that incentives were also a motivating factor in mobile technology adoption and noted, "In a concept of incentivizing, we need to find a way to get the buy-in voluntarily and make them seek it versus having to be ordered to do it." "Maybe that's a bonus … or a star reenlistment." In fact, one of the most important incentives in motivating Sailors in mobile learning was its relevance to the promotion process: "Until you get tie-in to how they are promoted and how they are evaluated against their peers, then this is just another online training platform, and that'll last until we replace it with something else."

## C. SUPPLEMENTAL FINDINGS

The data collected revealed three important themes outside the main concepts of PU and PEOU, namely MLSE, device ownership, and organizational policy. Based on previous research findings on the importance of self-efficacy in the adoption of new technologies, MLSE is considered significant. Our findings indicate that there are two other key factors: device ownership preferences and organizational policy concerns.

### 1. Mobile Learning Self-Efficacy

The literature review introduced the term *mobile learning self-efficacy*. Kumar et al. (2020) defined MLSE as "perceived behavioral control that depicts students' personal beliefs in their competence in performing a learning activity using their mobile devices" (pp. 208061–208062). In their study, Kumar et al. offered that MLSE impacted PEOU, attitude towards use, and behavioral intentions towards using mobile learning technologies.

Sentiments relevant to MLSE were mixed. Most participants thought they could navigate a mobile device to find career-related information and engage in the learning process. Several participants have used a mobile device for training and exhibited an overall positive

attitude towards using a mobile device for learning. For example, one participant studied for civilian licensure using a mobile phone application. Another participant accessed foreign travel training material via a mobile device. One participant reflected this confidence while using their personal cell phone.

> I can do everything with the use of my cellphone [:] … complete my training complete my job, complete whatever it is with the Navy. If I was offered the opportunity to have my cellphone and do my training, more than likely I'm going to complete my training.

On the other hand, one participant thought that the learning process would be less engaging (and therefore less effective) if using a cellphone, based on previous experience of use: "If you put it on my phone, my way of operating with my phone is I'm scrolling, scrolling, scrolling, right? I mean it's a little bit more mindless even than when I'm on my laptop or my desktop."

The data also showed that adding helper applications may positively impact some participants' sense of self-efficacy and their belief that mobile learning technologies are effective. These helper applications include a link to additional information (so they can do more research if interested), the ability to contact SMEs with questions, and a chat function to interact with peers.

### 2. Device Preferences

The second area where users offered specific additional feedback included perceptions on the relative utility of different mobile devices. Data collected indicated that participants were not primarily concerned with the type of mobile device for training (i.e., smartphone, iPad, etc.). Instead, preferences were context dependent. Participants' interview responses indicated that the decision on which mobile learning technology to use would depend on the type of training, the work environment, and the accessibility of resources. For example, one participant preferred a laptop because the size and function aligned with the tasks they were attempting: "I think just the fact that I can multitask on a laptop and it's the right size. I can read everything, and I can take it wherever I want." Another participant considered the type of training when determining preference: "I'm not going to try to do BLS [Basic Life Support] on my cell. I don't think I would recommend doing BLS on an app." Finally, one participant

valued the ease of access to the training material and would use any mobile device that provided accessibility: “Any effort to make this much, much easier to access, not necessarily like phone versus laptop versus workstation.”

Participants were divided on their preferences for personally owned devices versus a government-issued device. Those participants who preferred using their own device mentioned their reluctance to have one more piece of equipment that they were responsible for: “People would much rather be able to use their own devices at home, on their personal telephone, and be able to make it manageable vice being issued another item that you’re now accountable for.”

While some participants were distinct in their preferences between a personally owned device versus a government-issued device, other participants were less definitive. For example, one participant who completes maintenance in ship spaces indicated a preference for an issued device that was treated as a part of their toolset. As explained by the participant, this preference would allow quick access to downloaded references that are useful to their tasks. In this instance, the Sailor would return the issued device with the rest of the tools on completion of their shift. Another participant with a previous ship tour offered that their preference on a ship would be to have access as needed to a government-issued tablet. “I feel like I could just do it on my phone. … As for I guess seagoing commands, I feel like if I could have like a tablet or a designated device … I can complete my trainings.” Finally, one participant commented on the importance of isolating their personal equipment from government apps, stating that they would use a personal device only if they did not need to download a government app.

Participant responses highlighted several advantages and disadvantages of two ownership types, personal and government-issued. Some participants expressed the need to separate their personal life from work and thus have separate devices. At least one participant was concerned about personal data collected if they downloaded an app to their phone. Our study showed that participants who prefer to use their devices want to maintain privacy and do not want to be responsible for an extra item. For government-issued devices, the concern was that the history of government-provided equipment shows the burden of accountability

for lost or damaged equipment and the loss of productivity due to unavailable features or downtime for maintenance. Table 2 summarizes participants' preferences and concerns.

Table 2. Participants' Perceptions of the Pros and Cons of Device Ownership and Mobile Learning

| Device Ownership | Pros | Cons |
|---|---|---|
| **Personal Device** | • Personal investment in the device.<br>• Established satisfaction.<br>• Familiarity with the device.<br>• No accountability to command.<br>• Easier to just have one phone.<br>• The flexibility to choose place and time for training. | • Data charges.<br>• Personal resource constraints.<br>• Expectation to work/train after hours.<br>• Device compatibility with training material.<br>• Concerns related to reprimand for personal device use in the workplace. |
| **Government-Issued Device** | • The need to separate personal life.<br>• No personal investment is required. | • Too cumbersome to keep track of two phones.<br>• Security constraints prevent productivity.<br>• Financial and logistic burden on commands.<br>• Expectation to work/train after hours. |

### 3. Organizational Policy

Participants offered several policy concerns and preferences that we found appropriate to code under the concept of organizational policy. These include items related to internal coordination and building a culture of learning. Organizational policy encompassed procedures and protocols implemented Navy-wide or at a command level. These are policies, procedures, or actions that participants thought encouraged or constrained training and job performance with mobile learning.

#### *a. Coordination in Development*

The first contributor to the success or failure to adopt a mobile technology was the importance of attaining buy-in or coordination in development from users at all levels. Leadership plays an important role in this: "It would have to come from the leaders. …

Leaders would have to … show a benefit of it. … Leaders would have to … focus on what the Sailors would be able to obtain or gain." Many participants shared a similar view and frustration as this participant and emphasized the importance of building trust and buy-in:

> The Navy's going to force feed it down us. We're not going to like it. And they're going to tell us what we're going to do, and we're going to do it. And then this program, like everything else … someone's going to replace it.

Participants suggested that integrating the customer's requirements was critical to building buy-in: "Know … the [customer's] objective. … Meet the requirements. … Be trained. … Have buy-in." When asked what would make Navy training more effective, participants shared the importance of soliciting user input: "The right instructors [,] … the right materials [,] … soliciting feedback from the fleet on the quality of the product."

#### *b. Training Culture*

Our study indicated that personnel is concerned about mobile technology as it fits into the overall learning culture of the Navy. Included in this is the ability to complete training given competing priorities and the lack of timely training notifications. Participants relayed that training information is disseminated by a training officer or a member of the chain of command. The concern for some participants, mostly those with shipboard experience, was that this notification was often not timely. It is often difficult to complete the required training on time when resources and time are limited, and late notice complicates this challenge. Participants noted that they often had to contend with insufficient resources to complete training by the designated deadline. One participant relayed that training is particularly difficult in shipboard spaces where communications are intermittent:

> It's just very difficult for different rates to complete their trainings … to just send out an email … [and you're in] in the engine spaces or standing aft lookout. They're not going to get that email and they're going to be delinquent on their training.

Additionally, competing priorities are a concern on ships when mission requirements overshadow training and fewer resources (time) are allocated to training:

> The Navy's training policies require that we do the training while accomplishing several other missions, and that's the problem: When you have competing priorities, the highest priority gets precedence. … You don't have a focused time to train, so training is never the priority.

This participant believed that this is a problem of culture in the surface environment. With a lack of prioritization and no dedicated time in the command for training, personnel take the fastest route for training completion without real learning. This is true with or without mobile technologies. In addition, ashore and afloat, there is often a lack of relevance and good teaching practices in Navy learning. One participant indicated that training is a mandate with no real thought or priority to the process of learning:

> I do think part of that is reflected in the way trainings are done. They're pushed out, and as long as they're completed, good enough, right? We've checked that box. And concerns about the deep nature of learning or something like that probably are not really considered. And some of that's resource constraint, but some of it I think is cultural, too.

To overcome this cultural aversion to education, one officer participant, with over 10 years of service, thought that Navy boot camp and officer candidate school would be the best places to introduce mobile learning as part of the Navy learning experience. This view was shaped by the belief that older learners in the Navy will not be quick to adopt, if at all. Other participants supported this sentiment. One participant in the oldest age category of the study (35–50) and with over 15 years of service dismissed the idea of mobile learning, indicating that it was for younger learners only. Being "near retirement," they dismissed the usefulness of this type of training to their career.

## D. SUMMARY OF RESULTS

The results of the study were consistent with the literature review in that PU and PEOU had a positive impact on the users' attitudes towards the adoption of new technology. Productivity, career information management, and skills and competence were the three PU factors relevant to the adoption of mobile learning technologies. Participants want to enhance their productivity. Participants want all their career information in one place. And participants welcome opportunities to develop and maintain skills and competencies valuable to job performance and promotion. Our findings indicated that

Navy personnel closely correlated the four main factors of PEOU—learnability, effectiveness, efficiency, and satisfaction—with their willingness to adopt new mobile learning technologies. Participants want their information to be understandable and easy to use on any platform. They want their learning to relate and be relevant to their work and work context. They want to be able to accomplish their learning tasks in an integrated, one-stop shop. And participants need to be engaged and motivated to learn.

The choice of personally owned versus supplied mobile technology was highly contextualized. The participants preferred one type over the other depending on their personal situation. Users' beliefs about their ability (efficacy) to use a particular technology impacts their behavioral intent to use said technologies. The site of learning determined their preferences for small or large form factor devices. Organizational policies impacted their willingness to use their own or the organization's equipment.

Overall, our study found that PU and PEOU were interrelated in many aspects. For example, PU and effectiveness had a high co-occurrence in that training that increased accuracy and completeness of tasks enhanced participants' productivity. The extent to which the technology is perceived as easy to use influenced its perceived usefulness to the participants. We will discuss the results of this chapter and its applicability to our research questions in Chapter V, Discussion, Recommendation, and Conclusion.

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# V. DISCUSSION, RECOMMENDATIONS, AND CONCLUSION

This chapter summarizes and discusses the data collected for this study assessing user requirements for implementing mobile learning technologies in the Navy. First, we summarize and discuss the qualitative themes used throughout this study, and then we apply the results to the research questions: (1) Under what conditions will implementing mobile learning technologies provide the most value? (2) What are the requirements for delivering educational value to Navy users of mobile learning? (3) What are the pros and cons for Navy users of personal versus government-issued mobile learning devices? (4) How can Navy leaders select suitable options and deliver mobile learning?

Finally, in concluding this chapter, we provide recommendations relevant to the user requirements for implementing mobile learning technologies in the Navy. Additionally, we discuss the limitations of this study and provide recommendations for future research that could address the boundaries of this study and provide a more targeted and comprehensive analysis of the subject.

## A. DISCUSSION

In this section, the main findings of this study are summarized and discussed by major themes. Then, we apply important data from Chapter IV, Results, to answer the research questions. Device preferences as a major theme is not included in the Summary of Findings, as a thorough discussion of device preferences is provided in response to our third research question.

### 1. Summary of Findings

Overall, our study found that most participants are interested in mobile learning as a learning delivery option in the Navy. This finding is consistent with Schatz et al.'s (2019) study, in which they assessed 25 modernized learning options and found that participants had the most interest in mobile learning as the means to modernize learning in their respective militaries, including the U.S. military. However, we found that learners' acceptance of the mobile learning technology requires understanding their

concerns and ideal use of the technology in their environment. Furthermore, consistent with the literature review, we found that PU and PEOU impacted Navy personnel's attitude towards mobile learning technology adoption. We also had additional findings likely to influence participants' intentions towards use, MLSE, and organizational policy. To that end, our study concludes that the four vital elements impacting mobile learning technology acceptance in the Navy are PU, PEOU, MLSE, and organizational policy. Each element encompasses contributory factors that Navy personnel perceived as influencing mobile learning technology acceptance.

#### *a. Perceived Usefulness*

First, our study found that PU positively impacted attitudes and behavioral intentions towards mobile learning. Participants placed great significance on the ability of training and technology to improve their job performance. When assessing PU, personnel make judgments about job performance outcomes and factors that might influence these outcomes. In this study, these factors were productivity, career information management, and the attainment of skills and competencies. We found that these factors positively impacted PU. The extent to which participants perceived mobile learning technology as enhancing productivity is where the relevant and compatible resources are accessible. Participants were concerned that the technological infrastructure might not be available for all Sailors to benefit from mobile learning, particularly shipboard Sailors, but including Reserve Sailors. Despite these concerns, participants thought that access to the right resources at the right time would positively impact their productivity and job performance. Other productivity enablers for participants include the appropriateness of the mobile technology to the users' work environment (i.e., Can I easily use a mobile learning device in my shipboard work environment?), as well as the compatibility of the technology to the users' training needs (i.e., Can I learn the training content I need through a mobile device?).

Additionally, participants want all their career information in one place. Participants expect greater visibility to career development and advancement information in a mobile learning setting and value the ability to make timely career

decisions conveniently. However, some participants believed that junior enlisted Sailors are less likely to know where and how to access career development information and that the mobile learning technology ecosystem offered by the Navy should fill this gap.

The study also found that once Navy learners understand their career advancement requirements, they will be better able to connect learning objectives and lifelong learning opportunities to job performance outcomes. Participants welcomed opportunities to develop and maintain skills and competencies valuable to job performance and use mobile learning technologies to this effect (i.e., videos, diagrams, references, etc.). Where traditional classroom training was preferred, participants thought mobile learning technologies could provide additional support. This point is relevant to the element of skills and competence as participants complained that the learning objectives of some trainings are often not clear or seem irrelevant to their job performance. Furthermore, some training did not seem specific enough to facilitate a learning continuum for the advancement of job competencies. Convenient knowledge acquisition that will allow participants to acquire and maintain new skills and competencies is another benefit of mobile learning technology.

This study also identified that the factors that impact PU were interrelated. For example, career information management influenced PU to the extent that individuals would know what was needed to advance professionally. This knowledge in turn impacts personnel assessment of the skills and competencies required. The Venn diagram presented in Figure 7 represents the interrelatedness of the factors that participants found relevant to the PU of training and mobile technologies used for training.

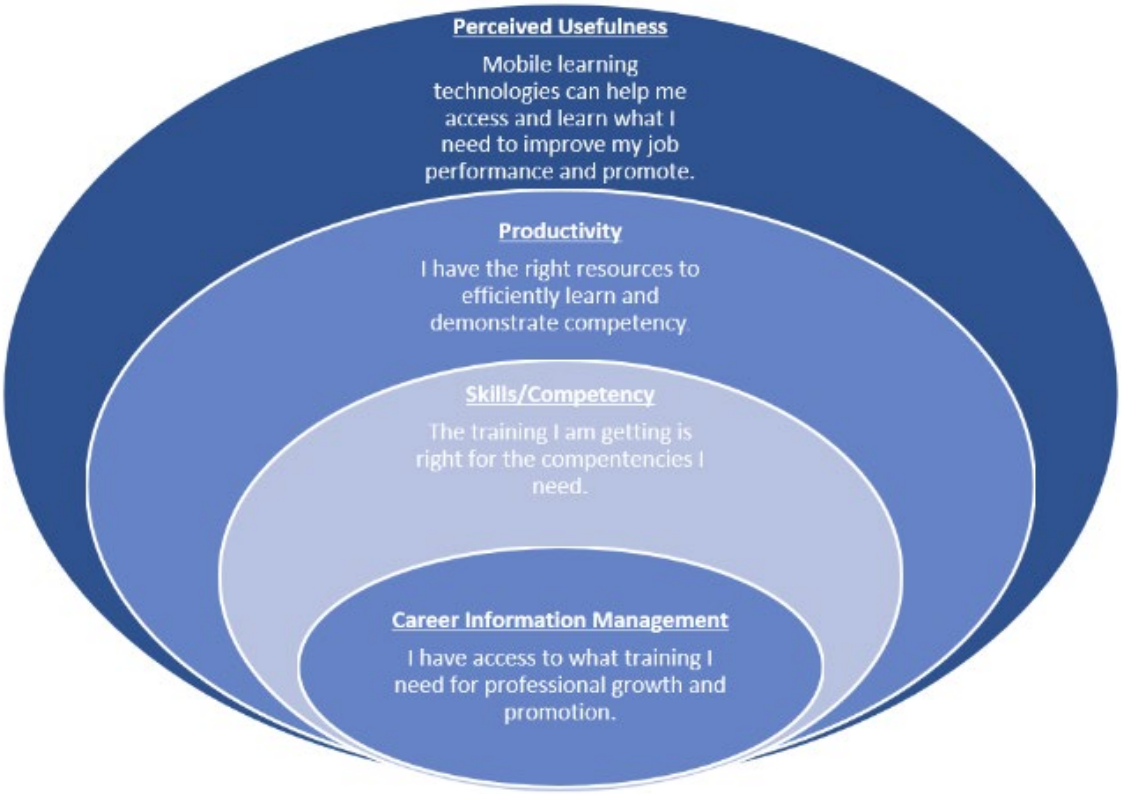


Figure 7. Interrelated Factors of Perceived Usefulness

### *b. Perceived Ease of Use*

We found that many usability requirement issues in delivering educational value to the Navy could be minimized if users' feedback on usability factors (learnability, effectiveness, efficiency, and satisfaction) were solicited on emerging mobile technologies prior to implementation. Attaining buy-in of users at every level in the Navy during the planning and developmental stages of a new technology could significantly increase the adoption of mobile learning technologies. Additional factors that increased the likelihood of adopting mobile learning technologies and improving educational value for Navy users were the ability to self-regulate and personalize trackable training that incorporated relatable fun scenarios, games, and videos to keep users engaged. The training should be consistent for all users regardless of instructor or environment to ensure training is uniformly conducted to improve educational value and provide Sailors and leaders confidence in the required skills.

All training should be collocated in an integrated, easy-to-find and easy-to-use platform that is outfitted with a simple search function. When a user believes a mobile technology is instinctively easy to understand and learn, they find interacting with it "simple or not too complex" and are more willing to adopt it. If users have difficulty locating, understanding, or navigating a mobile technology, they should have features such as chat and forums to collaborate with other users, as well as immediate access to 24/7 technical support. When users adopt a mobile technology, value in education is attained when the training is related to their specific job and they have the ability to use video teleconferencing to work in groups with peers or with instructors. Easy-to-use apps downloaded to a device can be incorporated into Navy mobile learning platforms to increase users' acceptance, improve visibility in locating required training, and add educational value with increased learnability and understandability of the training. All participants, regardless of demographic background, consistently valued these requirements.

#### *c. Mobile Learning Self-efficacy*

Additional findings suggest that previous experience with mobile learning technology positively impacted PU, PEOU, and attitude towards use. This signifies that participants who have successfully used their mobile devices in the past for learning are likely to perceive such activities as useful. Additionally, they would possibly determine the technology is easy to use and have positive attitudes towards using said technologies in the Navy for learning. This confidence in the use of mobile learning technology describes MLSE. Furthermore, it is consistent with Ruth et al.'s (2013) study of NPS and USNA students. In their studies, participants indicated that they often use their mobile devices to access learning material and would use mobile learning if it was an option in the Navy.

#### *d. Organizational Policy*

Last, the organization policies identified as an influencer of mobile learning acceptance are coordination in development and training culture. Participants expressed the importance of attaining buy-in and coordination in development from users and that leadership engagement is critical to this process. Additionally, participants believed that

training is often not a priority, and there is no real thought to the process of learning. This focus on training was significant, as participants' feelings towards current training and the Navy's approach to learning will impact their attitude and behavior towards learning. Where no changes in training and the learning process are evident, participants might look beyond the convenience offered by mobile devices and determine there are no real benefits to the training provided or the use of the mobile technologies to improve their job performance. This finding suggests that pedagogy should be an important factor when designing a mobile learning system, as participants expect effective learning.

### 2. Research Questions

In this section the results of our study is applied to our research questions. Specifically, we discuss Research Questions 1 through 3. A discussion on Research Question 4 is reserved for the Recommendations section where we can clearly identify a course of action that aligns to our study results.

#### *a. Research Question #1: Under what conditions will implementing mobile learning technologies provide the most value (learning/usefulness/ease of use)?*

The results of our study indicate that mobile learning technologies are likely to provide the most value when Sailors can associate the training and the technology to improved performance. Officer and senior enlisted participants offered that the extent to which mobile learning can be tied to Sailors' promotion will influence their decision to accept the mobile learning technologies. This finding indicated that value, as a matter of benefit versus cost, is dependent on the perceived benefits of better performance and career advancement outweighing the costs of mobile technology use (i.e., significant efforts to complete tasks and/or little impact on improving job performance). This finding was also consistent with Davis's 1989 study, testing the TAM, where he found that office workers found more value in technology that can improve their job performance.

The results of this study also support the TAM as a framework for predicting mobile learning technology acceptance in the Navy. Applying our results to this framework, we determined the factors that influenced participants, PU, and PEOU. The factors of PU are

concerned with improving performance. Where the benefits of improving job performance are evident, participants are likely to value mobile learning technologies. On the other hand, the factors of PEOU were concerned with the effort required to use mobile learning technologies. Where the effort required is more than the benefits realized, participants are likely to reject mobile learning technology. In fact, in determining value, we applied Aten et al.'s (2018) mobile learning technology acceptance model (see Figure 4) to assess our results. In Figure 8, we have modified the Aten et al. (2018) model to represent how participants are likely to determine value graphically.

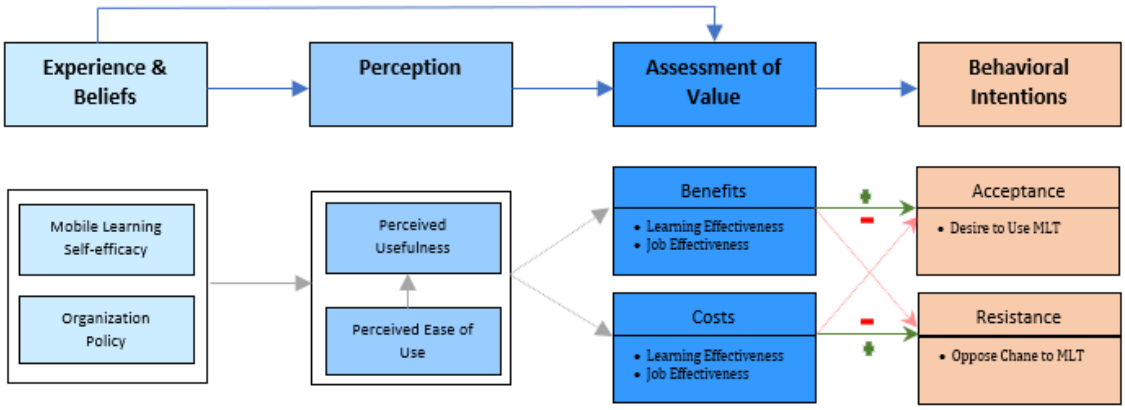


Figure 8. A Model of Mobile Learning Technology Acceptance. Adapted from Aten et al. (2018).

(1) Experience and Belief

Similar to Aten et al. (2018), we found that participants' experiences and beliefs influence PU and PEOU. We identified MLSE as a positive impact on both PU and PEOU. Additionally, we also identified organizational policies concerning coordination and training culture as impacting PU and PEOU. We also made an additional connection between "Experience and Belief" and "Assessment of Value." We believe that participants can directly assess value because of their experience using mobile technologies for learning, their input in the development of the system, and their belief that the training will meet their needs. For example, one participant who already uses mobile technology to study for a civilian exam indicated they would use mobile learning in the Navy. This was an expression of behavioral

intent easily determined by the usefulness and ease of use in using mobile technology in a civilian learning environment. Van der Bijl and Shortridge-Baggett (2002, as cited in Mensah, 2016), identified this idea as fundamental to the self-efficacy theory where individuals are attracted to activities with high confidence in their ability to complete.

(2) Perceptions

We can also attribute the factors of PU and PEOU previously discussed to *Perceptions* as identified in the Aten et al. (2018) model. Where participants can determine that mobile learning will improve their job performance, they are likely to assess that using the system will be useful. Consistent with Davis's (1989) study on the TAM, we can conclude that participants are likely to decide on benefit and behavioral intent based on their perception of usefulness and the effort required to use mobile learning technologies. Also consistent with Davis et al.'s (1989) revised TAM (see Figure 3), we found that PEOU positively impacted PU. This means that where participants perceived mobile learning technology as easy to use, it will influence that technology's PU. In addition, there were observable co-occurrences between several PU and PEOU factors. For example, PU and effectiveness (a PEOU factor) had a high co-occurrence in that training that increased accuracy and completeness of tasks enhanced participants' productivity.

(3) Assessment of Value

Consistent with Aten et al. (2018), learning effectiveness and job effectiveness, as measures of PU and PEOU, can also be used to characterize our results in terms of participants' estimate of value. Our study found that both PU and PEOU factors can be used as indicators for participants' perceptions of learning effectiveness. For example, effectiveness as a usefulness factor is the ability of participants to complete a skill or competency following a learning evolution. In contrast, effectiveness from an ease-of-use perspective reflects whether a learner can complete specific learning tasks within a learning task. Both learning effectiveness and job effectiveness impact the willingness to adopt.

On the other hand, in our study, job effectiveness is related primarily to PU, specifically with perceived performance outcomes using mobile learning technologies. For

example, Figure 7 demonstrated how the different factors participants identified as relevant to PU impact job performance (i.e., effectiveness in job completion).

(4) Behavioral Intentions

Overall, we may be able to determine participants' intent towards the use of mobile learning from the resulting cost–benefit analysis (assessment of value) they used in deciding PU and PEOU as well as their experience and beliefs. This suggests that participants' choices can be altered with changes in any of the PU or PEOU factors or as they gain more experience and changes in their beliefs. When participants assess that the benefits of mobile learning technologies outweigh the cost, they are likely to choose to use mobile learning technology as a modernized learning system in the Navy. On the other hand, where the cost of mobile learning technology (the increased effort and lack of relevance to job performance) is greater than the benefits of mobile learning, they will stick to the status quo. The determination is also consistent with Aten et al.'s (2018) research.

### *b. Research Question #2: What are the requirements for delivering educational value to Navy users of mobile learning?*

Actual ease of use can only be determined in the real-world application of mobile learning technologies. However, prior to using mobile learning technologies, users bring with them a history of prior use. This history of using both Navy and commercial mobile technologies has informed our users' expectations and can be used as a source for setting requirements for designing mobile learning that is easy to use and useful. As stated in our findings, these requirements include 10 acceptance criteria: three PU requirements (productivity, career information management, and skills/competencies), four PEOU requirements (learnability, effectiveness, efficiency, and satisfaction), MLSE, device preferences, and organizational policy.

The requirements for PU include ensuring the technology increases productivity. Requirements include accessibility and availability for users at any time and in any place and the ability to acquire logistical support. The technology should measure the appropriateness to task in the environment and ensure the learning material and technology are aligned and support real-world scenarios. The second PU requirement is that the technology supports

career information management. The technology should allow users the ability to take ownership of their career. The third PU requirement is that the technology should help develop the skills and competence needed to perform their jobs throughout life.

The requirements for PEOU include developing apps and technology that are learnable. Users should be able to intuitively understand the technology and be able to access help representatives at the point of need. The second requirement should include effectiveness measurements. Requirements should include interactive and engaging modules that allow users control and collaboration with others and be easy to operate. To make the technology easy to use, the requirements should include targets for efficiency. Users should be able to personalize/customize, track, and complete training in an integrated system and collaborate and interact with other learners. The fourth requirement is satisfaction, which is linked to motivation. Apps and technologies should be reliable and consistent across modules and platforms and should also be relevant and fun. These usability requirements include quantifiable criteria for testing the usability of planned mobile technologies and software. In our recommendations, we highlight the key criteria that should be taken into account when designing and testing for ease of use.

Additionally, the requirement for MLSE is that the mobile learning technology supports users' existing mobile technology experience and knowledge. The requirements for device preference should include the most functionally appropriate device (phone, tablet, laptop, etc.) and be either issued by the government or personally owned based on each individual user's specific context of use. Finally, requirements for organizational support include policies that prioritize training and seek buy-in from users at every level.

#### *c. Research Question #3: What are the pros and cons for Navy users of personal versus government-issued mobile learning devices?*

Study results indicated that the ownership of the mobile learning device was dependent on several factors, including the familiarity of the device, accountability, security, and personal investment. Participants identified several pros and cons on the two device ownership types. These pros and cons of device ownership were presented in Table 2 in Chapter IV, Results.

Supplemental findings indicated that the type of mobile learning device was context dependent. Through interview responses, we were able to identify that the decisions on which mobile learning technology to use depended on individual situations concerning the type of training, environment, and accessibility of resources. Based on the case, participants are likely to prefer one mobile learning device to another—making individualized decisions on which device can substitute, augment, or modify traditional learning for convenience and better performance. For example, a junior enlisted Sailor performing maintenance duties on a ship can use a mobile device to enhance their learning experience by augmenting maintenance resources using a mobile device rather than a physical reference manual. This Sailor would prefer a tablet that can be easily carried with their tools. This participant relayed that a tablet would be the right size to watch videos as a refresher on the maintenance task and look up pictures of parts and tools to verify the correct selection for task completion.

Another Sailor at a shore command would use their cell phone at work and at home to access career management information, study for career advancement, complete GMTs, and interact with other learners on topics of interest. One civilian learner would prefer to use their cell phone to access training information but offered that some training would need to be redesigned for delivery via a cell phone. This information can be seen in Table 3, a depiction of participants' device choices in different environments and for various tasks.

Table 3. Participants Context for Device Preferences

| Participant | Location | Activities | Device Preference |
|---|---|---|---|
| Junior Enlisted Sailor | Ship Maintenance Spaces | Watch equipment maintenance instructional videos. | Tablet |
| | | Look up pictures for tools and parts. | |
| | Ship's Berthing | Study for warfare device qualifications. | Cell Phone |
| | | Complete GMTs. | |
| Mid-Level Enlisted Sailor | Shore-based Medical Office or Home | Study for rating advancement. | Cell phone |
| | | Collaborate with other learners and SMEs. | |
| | | Complete GMTs. | |
| Officer | Shore-based Administration Office | Complete GMTs. | Laptop |
| | | Collaborate with other learners and SMEs. | |
| Civilian | Shore-based Office | Complete GMTs | Cell phone |
| | | Collaborate with other learners and SMEs. | |

## B. RECOMMENDATION

Our recommendation falls in line with our response to the fourth research question: How can Navy leaders select suitable options and deliver mobile learning? We recommend three actions for delivering suitable options for mobile learning.

- Use the decision tree presented in Table 4 to quantitatively assess technology options.

To ensure the mobile learning technology will work in the intended environment, it is imperative that our work is tested and evaluated to measure the usability factors we identified (learnability, effectiveness, efficiency, satisfaction), as emphasized by Bevan et al. (2016) in our literature review. We recommend usefulness surveys and usability testing to operationalize tasks based on multiple contexts of use, scenarios, work-related tasks, and Navy personas to quantitively evaluate, more accurately measure, and validate the qualitative concerns our study revealed (U.S. General Services Administration [GSA], n.d.; Bevan et al., 2016). Easy-to-use solutions can be measured by evaluating indicators such as the number of user errors and requests for help, number of attempts to access specific modules, ability to connect to the internet, ability to adjust audio controls, and ability to send/receive chat/forum message based on user preference to test requirements (GSA, n.d.). Each of the usability factors presented in Table 4 can and should be operationalized into specific user acceptance test scenarios.

Table 4. Decision Tree: How to Make Mobile Learning Work

| Concepts | Factors | Decision Questions |
|---|---|---|
| Usefulness | **Productivity** | • Is the technology appropriate to the task?<br>• Is the technology appropriate for the environment?<br>• Are the training content and technology aligned?<br>• Does the necessary technological infrastructure exist to support Navy-wide use? |
| | **Career Information Management** | • Does the technology integrate career information tracking and career advice?<br>• Does the technology allow Sailors to take ownership of their training and career advancement? |
| | **Skill/Competency Development** | • Does the technology align with the learning objectives of the training?<br>• Does the technology support emergent training needs?<br>• Does the technology support blended learning? |
| Ease of use | **Learnability** | • Do users understand how to use the technology?<br>• Can users utilize the technology with minimal training?<br>• Can users readily access help and get assistance? |
| | **Effectiveness** | • Can users identify, track, and accomplish their tasks?<br>• Can users easily access career management tools?<br>• Can users readily collaborate with each other?<br>• Can users readily interact with instructors and SMEs?<br>• Can users navigate and operate controls? |
| | **Efficiency** | • Can users access training information and tools in an integrated environment?<br>• Can users easily navigate training requirements?<br>• Can users access modules anytime and anywhere?<br>• Can users customize their experience?<br>• Can users easily access the technology?<br>• Can users be in control of their training and documentation? |
| | **Satisfaction / Motivation** | • Do users find the experience to be consistent across modules and platforms?<br>• Do users find the technology reliable?<br>• Do users buy into the need for training?<br>• Do users find the training to be fresh, relevant, and fun? |
| Mobile Learning Self-Efficacy | | • Is the technology convenient to access and use?<br>• Does the technology support interaction, including helper applications (i.e., chat and FAQs)? |
| Organizational Support | | • Does the organization prioritize training in its policies, procedures, and advancement activities?<br>• Does the organization provide mechanisms for stakeholder input throughout the development and implementation process? |
| Device Preference | | • Does the technology fit the functionality of the individual users' training/work environment?<br>• Does being provided a government-issued device create a challenge, burden, or barrier to accessing and completing training?<br>• Can users successfully access all training materials without challenge, burden, or barrier if they bring their own device? |

Table 5 presents some examples of how the usability factors in the decision tree can be operationalized for testing:

Table 5. Examples of How the Usability Factors in the Decision Tree Can Be Operationalized for Testing

| Example | Scenario | Measure |
|---|---|---|
| *Learnability example:* Can users readily access help and get assistance? | Ask the tester to get assistance on how to record a video on their smartphone | Success rate, time to complete task |
| *Effectiveness example:* Can users access career management tools? | Ask the tester to open their career road map | Success rate, time to complete task |
| *Efficiency example:* Can users access modules anytime and anywhere? | Ask the tester to complete a training module | Success rate, time to complete task in each training environment (e.g., afloat, OCONUS) regardless of user persona and environment (e.g., Reservist on weekends) |
| *Satisfaction example:* Do users find the training fresh, relevant, and fun? | Ask the tester to answer a satisfaction survey immediately after conducting training | Users report satisfaction and motivation after conducting training |

Furthermore, Sarker et al. (2019) noted the effectiveness of using a "user-centric context-aware decision tree" (p. 1152) in their study entitled "BehavDT: A Behavioral Decision Tree Learning to Build User-Centric Context-Aware Predictive Model." They reported that individual user preference and behavior had multiple contextual areas based on when, where, or why the mobile technology was used. Therefore, we recommend that our decision tree (in Table 4) be utilized as a method to design easy-to-use solutions for users of Navy mobile learning technologies. Our decision tree can help bridge the gap between Navy designers of mobile learning technology and the requirements of the users

who ultimately adopt the technology and improve learnability, effectiveness, efficiency, and satisfaction.

#### *a. Employ an iterative design test cycle.*

According to Marty et al. (2013), an iterative design process relies on users' feedback—applied over multiple iterations—toward an improved design. The data they collected in a three-iteration test cycle from over 1,800 participants in roughly a year and a half consisted of an "iterative, user-centered design approach to developing mobile learning applications" (p. 41). Their results show that with each iteration of design, ease of use improves (Marty et al., 2013). Therefore, we recommend that designers of Navy mobile learning technologies implement an iterative design test cycle to address the challenges identified in our research as barriers to technology adoption.

#### *b. Create a design system.*

In addition to the previously mentioned ease-of-use test recommendations, we recommend "design systems" as a centralized process to attempt to solve consistency and efficiency issues discovered in our research and to ensure that a system standard is implemented when designing and implementing usability testing (Fessenden, 2021). Design systems is an emerging industry practice and one of the many tools available to assist the Navy in incorporating standards to operationalize usability tasks that help capture best practices, reduce the inconsistencies in Navy training, foster improved technology adoption, and ultimately create a culture of learning (Fessenden, 2021).

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## C. CONCLUSION

The Navy is in the process of implementing RRL and is looking at technology solutions to deliver modern training capabilities anytime and anywhere. Mobile learning is a practical option to realize the vision of the chief of naval operations for RRL. To support the Navy initiatives, we conducted a qualitative study to answer the following research questions: (1) Under what conditions will implementing mobile learning technologies provide the most value? (2) What are the requirements for delivering educational value to

Navy users of mobile learning? (3) What are the pros and cons for Navy users of personal versus government-issued mobile learning devices? (4) How can Navy leaders select suitable options and deliver mobile learning?

We conducted 13 semi-structured interviews of Navy active duty, reserve, and civilian personnel across ranks and job communities to answer these questions. We found that most participants were interested in mobile learning. Still, their acceptance of mobile learning technologies is dependent on their assessment of PEOU of the technology and PU to job performance. Additionally, we found that participants' device preferences were context-of-use dependent.

Therefore, to effectively deliver mobile learning in the Navy we recommend evaluating user requirements, operationalizing and testing usability factors through an iterative design test cycle, and creating a design system to implement best practices for usability testing and training consistency.

## D. LIMITATIONS AND RECOMMENDATION FOR FUTURE RESEARCH

There are several considerations for future studies, as we noted some limitations in our study. First, the data we collected were preliminary to understanding high-level issues that might impact adoption. To get a more comprehensive assessment of the degree of Sailors' perceptions across the Navy, we recommend that a qualitative study using a more extensive demographic sample be conducted to understand these issues better. We provided vital questions that future researchers can use to develop a quantitative survey to rank the importance of the concerns highlighted by our participants to the broader subset of Navy personnel.

Another area of interest that demands greater attention is observing the context of use for mobile learning technologies in different environments. In Table 3, we began a context-of-use outline, using basic user profiles, locations, tasks, and device preferences. We recommend a more detailed study capturing specific user profiles across the Navy. Our study indicated that decisions on the type of device are context-dependent. Therefore, a field study to understand at a high level what user tasks and criteria for device use would be beneficial to the Navy. Observing personnel in the different environments and

conducting various types of training on different devices might assist the Navy in determining the type of device(s) that offer the most usability and usefulness for job performance.

Our study included participants who were currently on a ship or were stationed on a ship at one point in their career. Participants raised many concerns regarding the technological infrastructure on a ship to facilitate shipboard Sailors' participation in mobile learning. Therefore, we recommend future studies with a broader sample of shipboard Sailors to understand their specific needs. Last, we conducted our analysis using the TAM framework to assess ease of use and usefulness perceptions. We recommend usability testing to provide measurable data to implement a mobile learning ecosystem that provides the best value.

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# APPENDIX A. RECRUITING EMAIL

Hello,

We are researchers at the Naval Postgraduate School conducting a study to investigate the best value solution (phone, tablet, computer, etc.) and requirements to deliver mobile education and training capability anytime and anywhere to the Navy. The findings will assist the Navy in the best use to incorporate mobile learning technologies and develop a mobile learning solution that facilitates user learning.

We will be interviewing 10 to 25 people. Based on your experience as a Navy learning system user we would greatly appreciate your participation in an interview, by phone or via virtual meeting (Zoom, Teams, etc.), which will last approximately 45–60 minutes

Participation in this study is confidential and voluntary and you may change your mind and decide not to participate at any time, even after the research has started. All participant information will be kept confidential. Interview data will be stored separately from personally identifiable information (PII) and linked with a coding key. Participant identities will be protected in reports through the use of pseudonyms. All records and data will be stored in secure facilities. If you are willing to participate in this study, please respond to Researcher X or Y at X@nps.edu and Y@nps.edu. Regards,

Researchers
XYZ

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# APPENDIX B. INFORMED CONSENT

We are researchers at the Naval Postgraduate School conducting a study to investigate the best value solution (phone, tablet, computer, etc.) and requirements to deliver mobile education and training capability anytime and anywhere to the Navy. The findings will assist the Navy in the best use to incorporate mobile learning technologies and develop a mobile learning solution that facilitates user learning that is easy to use. We will be interviewing 10 to 25 people. Based on your experience as a user of the system we would greatly appreciate your participation in an interview, by phone or via virtual meeting (Zoom, Teams, etc.), which will last approximately 45–60 minutes.

Participation in this study is confidential and voluntary and you may change your mind and decide not to participate at any time, even after the research has started. All participant information will be kept confidential. Interview data will be stored separately from PII and linked with a coding key. Participant identities will be protected in reports through the use of pseudonyms. All records and data will be stored in secure facilities.

Do you consent to participate in this study?

We would like to record our interview to accurately capture your response. The interview recording and transcript will also be kept confidential as previously described. Do you consent to us recording this interview?

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# APPENDIX C. INTERVIEW QUESTIONS

**Let's talk about what Navy policies influence the use of mobile technologies.**

1. Let's start on your thoughts on why the Navy has the training policies it does? Describe different types? Goals for policies? Problems-example? *(Usefulness)*

2. Talk about the effectiveness of Navy training for individual Sailors. Skill development/ refresher/decay? Career development? Learning with peers? Mentoring/feedback? Examples? *(Effectiveness)*

3. What policies or processes make training desirable or satisfying (or not)? Privacy? Security? Gaming? Reference materials? Automated recommendations? *(Desirability/ Satisfaction)*

4. Talk about how Navy policies make it easy or hard to use learning technologies. Tracking training? Accessing training? Using training? Tailored learning? Managing career? Afloat versus ashore? *(Efficiency/Learning by Use Case)*

**What new or proposed policies are being considered?**

5. Given all that we've discussed, how might the Navy make learning more mobile and portable? Types of mobile technology that is/should be considered? Navy-issued tablet/ phone or personal? Limitations/benefits of phone, tablet, laptop, desktop, VR headset? *(Technology Preferences)*

**What is your organization/group's process for approving new technologies?**

6. Finally, summarize what things would make it likely for Navy personnel to approve/ adopt the use of mobile devices? *(Technology Adoption)*

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# APPENDIX D. PARTICIPANTS' DEMOGRAPHICS

| Participants' Demographics and General Information | | |
|---|---|---|
| **Concept** | **Characteristics** | **Frequency** |
| Gender | Male | 6 |
| | Female | 7 |
| Age | 18–24 | 0 |
| | 25–34 | 4 |
| | 35–49 | 8 |
| | 50+ | 1 |
| Ethnicity | White | 4 |
| | Hispanic or Latino | 3 |
| | Black or African American | 6 |
| | Native American or American Indian | 0 |
| | Asian or Pacific Islander | 0 |
| | Other | 0 |
| Rank | E-1–E-4 | 1 |
| | E-5–E-6 | 3 |
| | E-7+ | 2 |
| | O-1–O-3 | 3 |
| | O-4+ | 2 |
| Status | Active Duty | 10 |
| | Reservist | 1 |
| | Civilian | 2 |
| Duty Station | Current Shore | 12 |
| | Current Afloat | 1 |
| | Overseas | 0 |
| | Previous Afloat | 5 |
| Community | Administration | 2 |
| | Medical | 4 |
| | Aviation | 1 |
| | Information Warfare | 0 |
| | Nuclear | 0 |
| | Seabees | 1 |
| | Security | 0 |
| | Special Warfare | 0 |
| | Submarine | 0 |
| | Supply | 2 |
| | Surface Engineering | 1 |
| | Academic | 2 |

Table format adapted from Mwapwele (2018).

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# APPENDIX E. THEMES, CATEGORIES, AND SUBCATEGORIES

| THEMES | CATEGORIES | SUB-CATEGORIES | |
|---|---|---|---|
| Perceived Usefulness | Productivity | Accessibility and Availability | |
| | | Appropriateness and Relevance of Technology | |
| | | Maintainability | |
| | Career Information Management | | |
| | Skills and Competences | Learning Objectives | |
| | | Lifelong Learning | |
| | | Blended Learning | |
| Perceived Ease of Use | Learnability and Understandability | Technical Support | |
| | | Visibility | |
| | Effectiveness | Interactivities | |
| | | Engagement | |
| | | Collaboration | |
| | | Operability | |
| | | Relatedness | |
| | | User Control | |
| | Efficiency | Cognitive Effort | Integrated |
| | | | Personalized/Customized |
| | | | Trackable |
| | | | Consistency |
| | | Physical Effort | Portability |
| | | Timely/Easily Retrievable | |
| | Satisfaction | Enjoyable | |
| | | Motivation | |
| Organization Policy | Coordination in Development | | |
| | Training Culture | | |
| Mobile Learning Self-efficacy | | | |
| Device Preferences | | | |

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